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Testing Welding

FOR the joining of metals, soldering and brazing have limitations which are soon reached. Good welds have long been made by hammering or forging, but except where special facilities have been available, this process has been confined to such work as could be handled in a forge.

For the joining of the members of structures, the plates of ships and of boilers, the frames of machinery, etc., the engineer has resorted to the use of rivets.

A riveted joint is not an embellishment to a structure. It adds weight, involves objectionable irregularities in thickness and surface protuberances, and a joint held tight only by the pressure of the sheets upon one another cannot be depended upon to remain entirely free from leakage.

But properly made it is safe, and its proper making can be assured.

Developments in chemistry and electricity have made possible the local concentration of heat in large amounts and at high temperatures.

This has led to the possibility of joining metals by fusing the juncture and forcing them together, or by fusing a joining metal between them, so completely that the weld is often as strong as or stronger than the material joined.

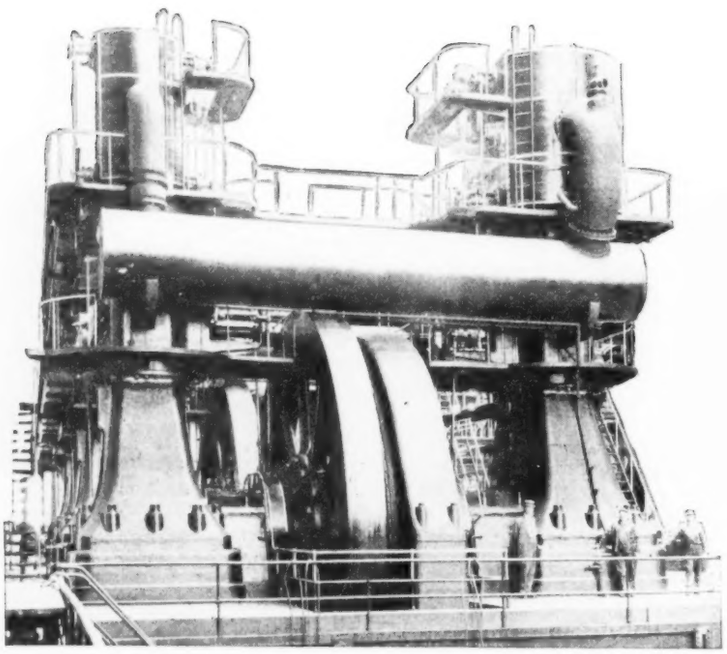
But how can it be known that the weld is complete, that the joint is strong and ductile and that the metal in its vicinity has not been affected?

The tremendous effect of the general application of welding upon the design and construction of metal structures is obvious.

The thing that would most immediately conduce to such general adoption is the discovery of some simple, easily applicable method of demonstrating the integrity of the weld itself and the absence of impairment of the contiguous material.

Surely within the resources of the physicist who can dissociate the atom, there is something that will render perceptible the relations of the molecules within and about a weld.

F. R. Low



One of the eight engines. Note men in foreground

INSTALLED in 1902, just before the steam turbine began to sweep the large-station field, eight 5,000-hp. Corliss engines are still operated on emergency or stand-by service at the Kingsbridge Station, New York City. Their story as related to a member of the *Power* staff by the man who supervised their erection.

Giant Engines Still Operate In Kingsbridge Station

WHILE it is true that the steam turbine, with its compactness and high efficiency, has made almost a clean sweep of the large-station field, the towering engines erected in the palmy days of the big Corliss have not all been humbled by their modern successors. Some of the old engines are still operated occasionally, and work as smoothly as the day they were first started.

At the Centennial Exposition, held in Philadelphia in 1876, visitors were startled by the greatest Corliss ever built—1,400 hp. in a single machine. It seemed to the engineers of those days that the ultimate in size had been achieved. But it proved to be only a start. Bigger engines were built, and still bigger ones.

A peak was reached around 1902, when the 7,500-hp. Corliss generating units were installed at the Fifty-ninth Street Station of the Interborough Rapid Transit Co. to run New York City's first subway. Those engines, which were later equipped with exhaust turbines, were the largest ever built with the possible exception of a few blooming-mill engines. Their size has never since been equaled in units driving generators.

But this story is not concerned with Fifty-ninth Street or with the Seventy-fourth Street Station (also in New York), which was also equipped with large engines of similar construction. It deals rather with memories that cluster about the Kingsbridge Station at Two Hundred and Nineteenth Street and Harlem River, about a half-mile north of the well-known Sherman Creek Station of the United Electric Light & Power Co. Built in 1902 for the Third Avenue Railway Co. and now leased by the New York Edison Co. for emergency or standby service, it is a good example of the best engineering of that period.

Its eight 5,000-hp. Corliss engines are still all there, exactly as originally installed. No new units have been put in; none has been removed. What is more, they are all ready to start at a moment's notice when peak loads call for their assistance.

This lot of engines was part of an original order for sixteen given by the Third Avenue Railway System to the Westinghouse Machine Co., of Pittsburgh. It was the largest engine order ever given to an American manufacturer up to that time. Orders were placed in 1896; installation began in 1901. The completed station was put in service in 1902, and continued in regular operation until a few years ago, when it was relegated to stand-by service.

All these engines stand today in prime condition for successful operation. While obsolescence has obviously taken place (else they would not now be stand-by units), depreciation has been practically zero. The engines are just as tight and strong as when first put in; they run as smoothly and with the same economy.

Not long ago a member of the *Power* staff had the pleasure of learning the history of these old engines from Robert M. Hughes, the man who supervised their installation. The story is here retold for those *Power* readers who are interested in the great engineering accomplishments of days gone by.

The engine foundations were in before Mr. Hughes came on the job as superintendent of erection for the

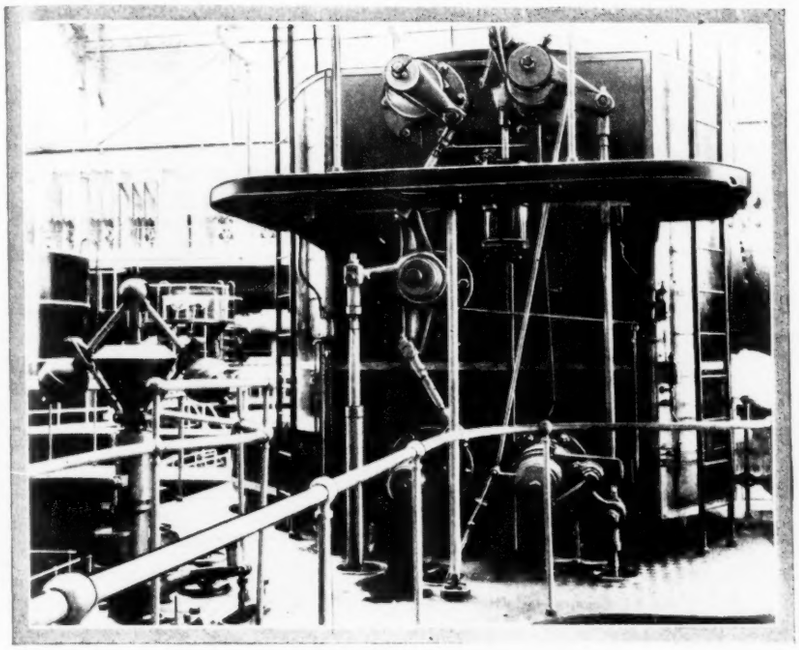


Fig. 1—High-pressure cylinders, showing releasing Corliss valve gear

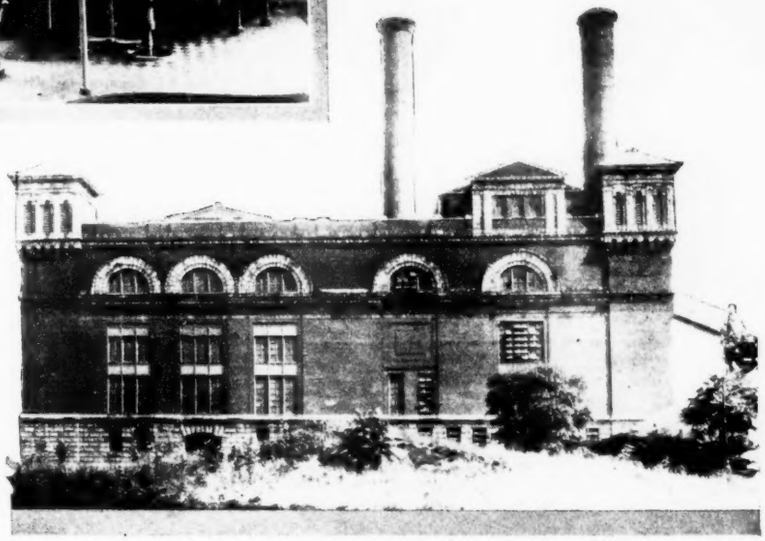


Fig. 2—Outside view of the Kingsbridge Station

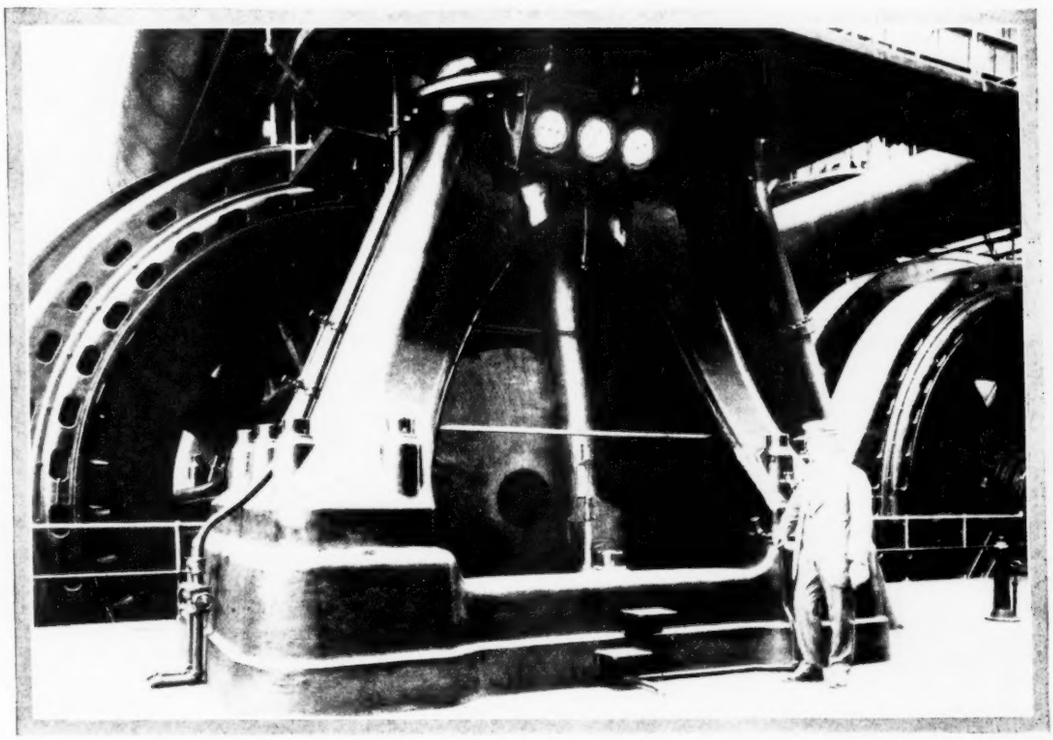


Fig. 3—Close-up of the base and frame with Mr. Hughes

Westinghouse, Church, Kerr Company, who were the designing and erecting engineers on this job. The first engine arrived at the plant in March, 1902, shipment being made by rail from Pittsburgh to Bayonne, N. J., and from there to the plant by lighter.

Each engine had two bedplates, one for the high-pressure cylinder and one for the low. The bedplates weighed 43 tons each and had to be shipped separately on flat cars designed and constructed especially for the purpose. These cars were so built that the bedplate could be placed on edge with the heavy bearing-supporting edge underslung to bring the center of gravity as close as possible to the track level.

The cylinders, connecting rods, pistons, piston rods, frames (in two halves), etc., were shipped in other cars. Some idea of the massiveness of these parts may be gained from the following enumeration of weights: Crank disk, 24,000 lb.; low-pressure piston, 13,000 lb.; high-pressure piston, 3,200 lb.; connecting rod, 6,000 lb.; crosshead, 6,000 lb. Even these weights were insignificant in comparison with those of the crankshaft and flywheel, of which more will be said in a moment. Not counting the generators, which were furnished and erected by the Westinghouse Electric Co., each completed engine weighed 600 tons.

A derrick on the lighter loaded the parts on a special car which ran on a track leading into the engine room. After the car had been pulled into the room with block and tackle, the parts were lifted off and placed in position with the 100-ton traveling crane.

The naked shaft as it came from the Bethlehem Steel Co. weighed 73,000 lb. The flywheel was 26 ft. in diameter and weighed 150 tons. It was machined and finished ready for erection in the shops at Pittsburgh. There were five sections, each being a steel casting comprising a portion of the rim with two spokes. In addition there were ten slab pieces, five to go on each side of the rim.

The hub was in a single piece with an annular "groove" to take the spokes, which were clamped between the two sides with three 4-in. bolts for each spoke. Arrowhead links were used to connect the sections of the rim. These were slipped into place red-hot, and upon cooling drew the sections of the rim tightly together. The slab pieces were attached on the sides with broken joints. For each slab thirty 3½-in. rivets were slipped in and driven cold with a special alligator having 10-in. hydraulic cylinders. Additional arrowhead links were used to join the adjacent slab pieces.

The center section of the flywheel was 12 in. wide.

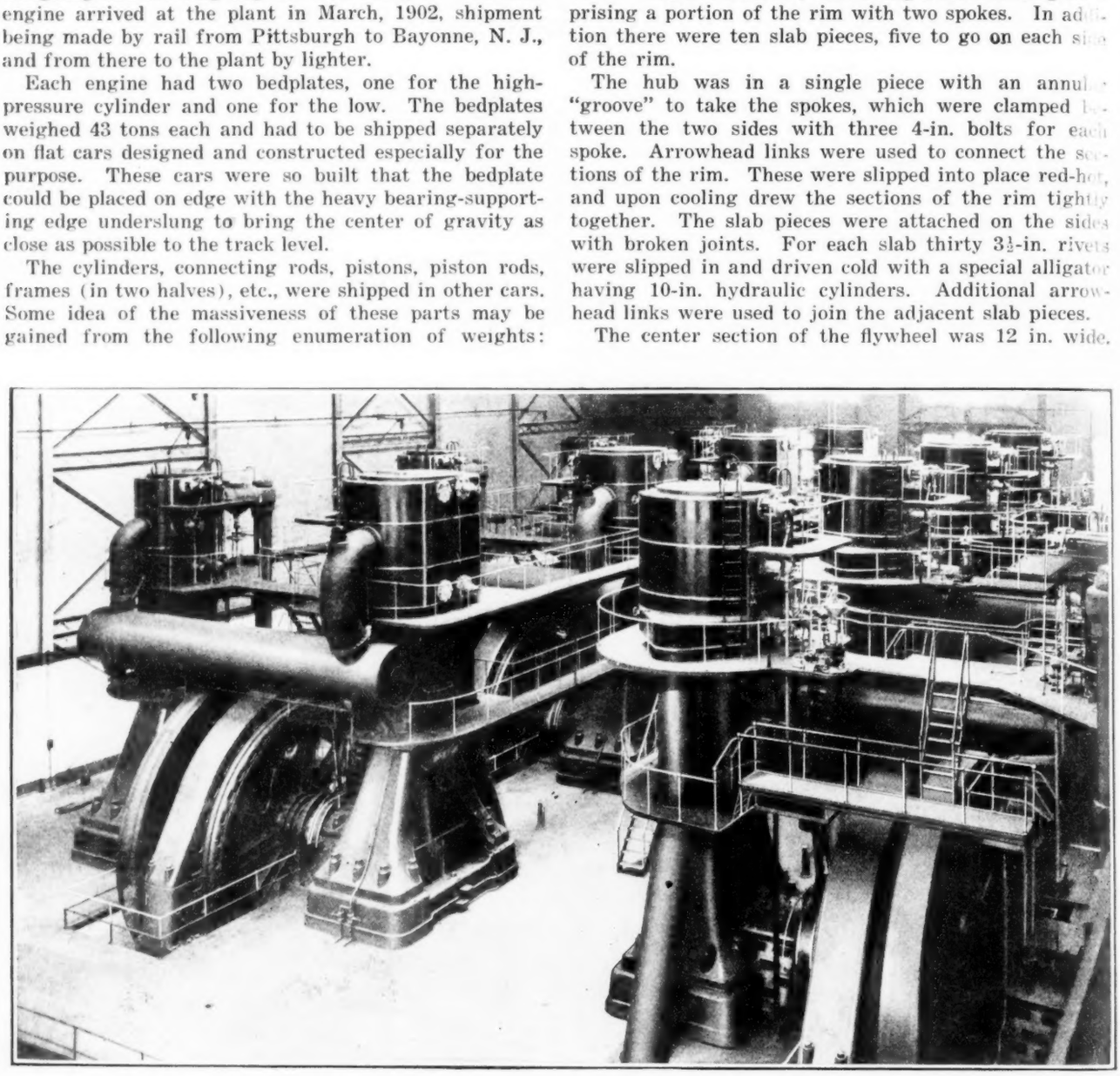


Fig. 4—From the top gallery of the engine room, the eight engines with their sixteen cylinders, loom up like a city of skyscrapers. The high-pressure cylinders of the near row are hidden from the camera

An additional 7-in. thickness of slab on each side brought the total to 26 in. It is worth noting that the wheels ran almost perfectly true, although the parts had never been assembled before they were brought to the Kingsbridge station.

The hollow shaft supporting the flywheel rested in bearings 5 ft. long. The latter were lined with high-grade babbitt top and bottom. This had been hammered in and bored true at the Pittsburgh factory. Spherical pads at the bottom of the bearings allowed for correct alignment with the shaft bent by the weight of the heavy flywheel.

The correctness of the design and the care used in erection are evidenced by the fact that none of these bearings has ever been replaced or rebabbitted. In fact, there has been no bearing trouble of any sort, nor

have any of the brasses of the connecting rods ever been replaced or given trouble.

While the spherical pads just mentioned took care of the deflection of the shaft as far as the bearings were concerned, something more was needed. It was necessary to tilt the two bedplates slightly to bring the high- and low-pressure cylinders in line with the plane of rotation of their respective cranks and to have both cylinders depart by an equal amount from the true vertical. The proper inclination was determined by a specially constructed level, and the bedplates were shimmed up the necessary amount by wedges. Then the vertical frames were bolted in place.

As already intimated, these engines were cross-compound units of a class that had been brought out by the E. P. Allis Co. The bore of the high-pressure cylinder was 46 in. and of the low-pressure 86 in. The common stroke was 60 in., and the cranks were set at 90 deg.

The crankpin had a diameter of 14 in. and was 14 in. long in the bearing. Piston rods were 8 in. in diameter. Regular releasing Corliss valve gear was used with two eccentrics on each side.

With 150-lb.-gage saturated steam, 26-in. vacuum and running at 75 r.p.m., each of these engines developed 5,000 i.hp., the generators producing 3,500 kw. The most efficient load is around 3,000 kw.

The vacuum was furnished by two barometric condensers located in the boiler room. These were furnished by the H. R. Worthington Co.

While Mr. Hughes had nothing to do with the boiler

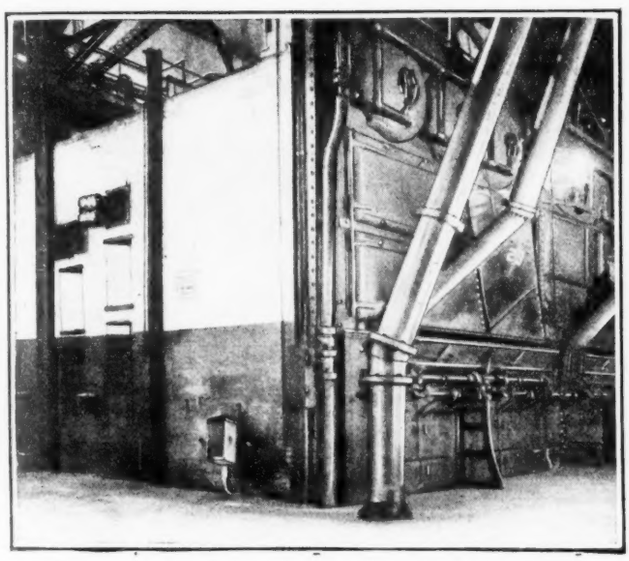


Fig. 5—Note low setting of the boilers, which represented standard practice in 1902

room, a few points about the equipment there may be of interest as indicating the most advanced practice at the time this station was built. As is the case with the engine room, the boiler room stands today practically as when it first went into operation. There are thirty water-tube boilers, each having 5,000 sq.ft. of heating surface, and fired by Roney stokers. Each boiler has three longitudinal drums. To the present-day engineer the most interesting thing about these boilers is their low setting, the lower end of the tubes being only 4 ft. above the fire.

The four cast-iron economizers, with their huge engine-driven induced-draft fans, are not now in use. One soon returns to the engine room, where centers the real old-time romance.

Even today one cannot look at these fine old engines without a feeling of awe because of their size and the tremendous forces involved in their operation. It is not difficult to imagine the pride taken in this plant by those who designed it and erected it, and by the

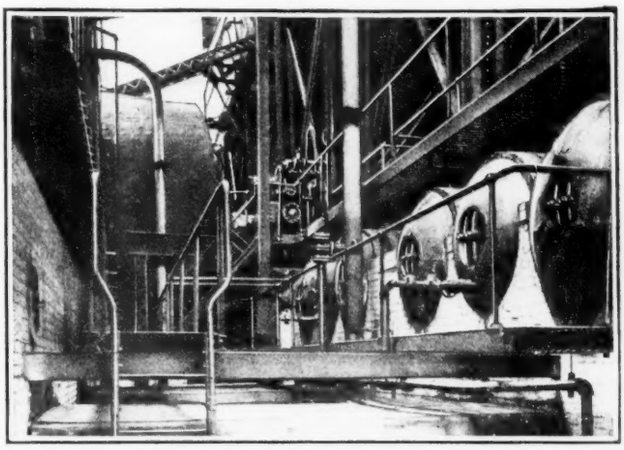


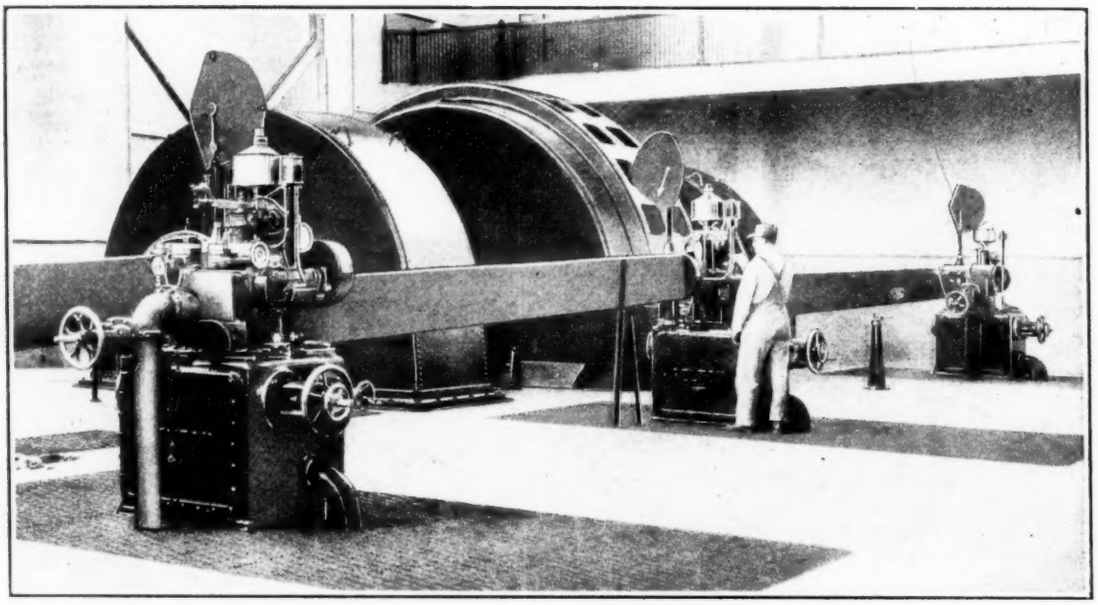
Fig. 6—Low speed means large size. The curved object in the background is not the paddle housing of some river-boat, but the casing of the engine-driven forced-draft fan. The cast-iron economizer may be seen on the left

men who ran it. No mechanism ever developed by man has had a greater appeal than the large Corliss engine.

But times change and engineering progresses, sometimes in a straight line and sometimes by starting off on an entirely new tack. Such a parting of the ways came almost simultaneously with the start of the Twentieth Century.

The steam turbine, invented as a toy by Hero two thousand years ago and made a real machine by de Laval and Parsons around 1900, began to loom up as a commercial possibility. Economics always wins in the long run, and the turbine with its much lower cost and space occupied, followed later by better economy (in large sizes), soon rang the knell of the large engine for new plants. In 1905, not so long after this plant was started, a 5,000-kw. turbine was installed at Hartford, Conn. Soon the turbine practically swept the field so far as new construction in large plants was concerned. In some of the old plants, where the investment had already been made, they still play a modest part.

THE TWO PRINCIPAL TYPES OF APPARATUS for the external softening of boiler feed water are zeolite softeners and lime-and-soda softeners. In the former the water is passed through a bed of the insoluble sand-like zeolite which is regenerated from time to time by the use of brine. Lime-and-soda softeners may be intermittent or continuous in operation. They may treat the water cold or after it has been heated nearly to 212 deg. Aside from internal treatment, which is still widely used, the two systems of water treatment most used in power-plant work are the hot-process lime and soda and the zeolite.



The Chief Operator Tells

How Large High-Head Hydro-Electric Units Are Started

By R. B. GREENWOOD
Chief Operator, Moccasin Plant, California

AT THE Moccasin plant, of the City of San Francisco, Calif., the four generating units are rated at 20,000 kva., 20,000 hp. and operate at 257 r.p.m. under an effective head of 1,250 ft. Individual direct-current exciters are used, and the hourly output of this station is generally in excess of 80,000 kilowatt-hours.

There has been established the practice of starting and synchronizing the generating units practically as rapidly as operating conditions permit. Extreme haste, such as may lead to destruction of equipment, has been avoided, yet the various operations necessary to start these large units are performed without delay. It has been found, by timing with a stop watch, that under favorable circumstances these units may be started, synchronized and partly loaded in 55 seconds.

While no troubles have been caused by starting the units as quickly as possible, a year's experience has indicated that under normal conditions acceleration to full speed should require approximately two minutes. This period enables the hydraulic operator to start the unit gradually, accelerate it to full speed without shock, and wastes the minimum amount of water through the auxiliary, or relief nozzles. It is probable that somewhat slower starting time than was originally aimed for will result in lower maintenance charges. Under abnormal conditions, such as low system frequency, units may be started as rapidly as possible without consideration having to be given to possible shocks to the unit or abnormal pressure variations in the penstocks. So far as hydraulic conditions are concerned, these high-head units may be started as rapidly as desired without fear of excessive pressure variations, since the auxiliary nozzles effectively prevent them.

Each unit consists of two impulse wheels, each of which is under the control of a direct-action Pelton governor. All eight governors are easily kept in first-class condition, therefore any one will readily hold the speed sufficiently close to permit of rapid and accurate synchronizing. In some plants it has been found that generators can be most quickly started and synchronized on hand control, but at Moccasin tests have proved that greatly superior results are obtained by depending entirely on governor control when starting.

Visual Signals Are Not Used

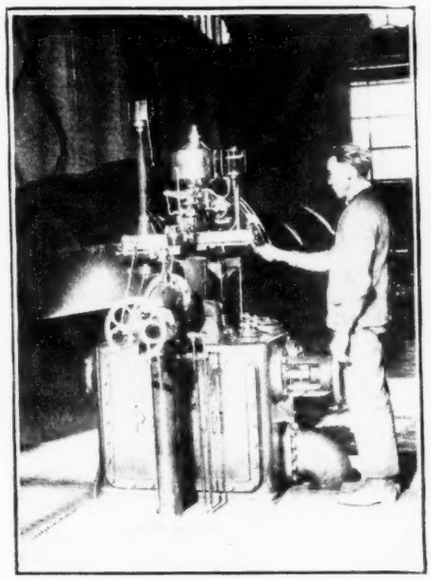
Visual signals are not used at Moccasin. A public-address, or loud speaker, system is used for the transmission of practically all operating instructions. In the generator room it is necessary for the hydraulic operators to proceed to the nearest loud speaker, one being mounted near the governors of each main unit, when an order is to be received and acknowledged.

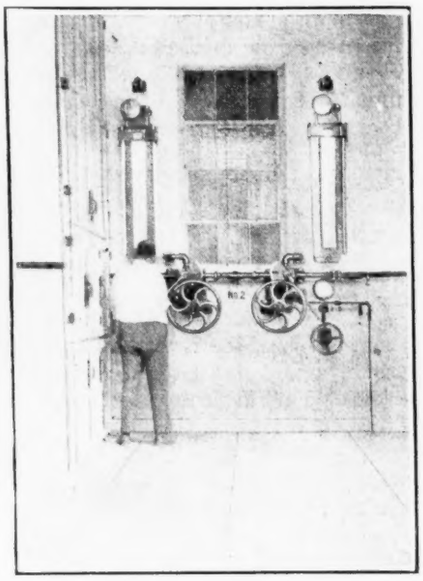
An additional loud speaker is mounted above the benchboard in the control room. Speech issuing therefrom can be clearly understood in any part of this room. This feature is particularly convenient, as the switch-

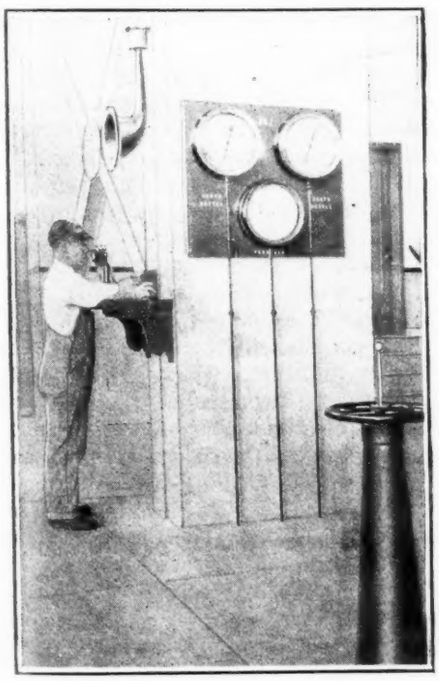
board operator enters directly on the log sheet the numerous readings that are necessarily transmitted to him hourly by the hydraulic operators. The microphone, or transmitter, for the several loud speakers in the generator room is supported on a pantograph arm, in a central position on the benchboard.

Two electric signal horns in the generator room are simultaneously sounded from the control room when an order is to be transmitted to the generator room. The hydraulic operator acknowledges this audible signal after proceeding to the nearest station by giving the number of the transmitter into which he is speaking. In order to eliminate all conversation and attendant unnecessary delay when a unit is to be started, a "Start Unit" signal is sounded. Since more than one unit may be shut down at the time of giving the order to start the second unit, the hydraulic operators are instructed, by loud speaker, which unit is to be first started. The unit first shut down is usually the first one started.

In order to insure synchronous speed without the necessity of adjusting the governor synchronizing motors when starting, these adjustments are made after the generator breaker is opened. At this time one nozzle is completely closed by operating the synchronizing motor of its governor. Then, with the synchronizing plug inserted, the other governor is adjusted by the switchboard operator to maintain synchronous speed. This adjustment requires little time, and after being made, the nozzle is closed by the hydraulic operator, who runs the load-limit device to the closed position. After the second governor is adjusted in the same manner as described, its load limit is also run to the closed position, and since both nozzles are closed, the generator will come to a standstill. Either governor will now maintain synchronous speed when it assumes control







Visual signals are not used at the Moccasin plant. A public address, loud-speaker system is employed for the transmission of practically all operating instructions, two installations of which are shown on the left and in the upper left

Above—The hydraulic operator starts the unit by means of the load-limiting device on either of the two governors on each unit

Above, right — Operating a penstock valve. The penstock valves provided for admitting water to the nozzle bodies are normally o p e n, being closed only when work is being done on the unit

Right—Switchboard operator synchronizing a generator

of the unit, provided the bus frequency is 60 cycles. The interconnected system of which Moccasin forms a part is so large and its troubles so rare that the frequency is usually normal. If not normal, the switchboard operator obtains correct speed by operating the governor synchronizing motor. The synchroscope is not visible from any governor.

Preparations for Starting

When the start signal is heard, the hydraulic operator first starts the high-pressure triplex oil pump by simply closing a knife switch, then proceeds on a run to the unit to be started and turns high-pressure oil into each bearing. The high-pressure oil is at 290 lb. per sq.in., and although the units may be safely started without other lubrication than that afforded by the oil rings, the application of oil at high pressure permits of a gentle start being made, insures more than ample lubrication and serves to replenish the oil supply in the bearing wells.

After opening the high-pressure oil valves, of which there are two, the hydraulic operator proceeds to either governor and starts the unit by means of the load-limit device. This device causes the power nozzles to remain in any desired position so long as the governor (unit) speed is below 63 cycles. Since during the process of starting the speed is necessarily less than 63 cycles, the nozzle opens as the load limit cam is moved toward the open position. A nozzle opening of 2 per cent, or 0.1 in., is sufficient to start the unit. Without high-pressure oil applied to the bearings, a nozzle opening of 12 per cent is necessary for starting. When, in approximately two minutes, full speed, 60 cycles, is attained, the governor head automatically assumes control. The load-limit cam is then advanced slightly farther to permit sufficient water to be directed on the wheel to prevent the possibility of the speed decreasing.

So far as the hydraulic operator is concerned, the generator is now ready for synchronizing. He accordingly drops the automatic shutdown stirrups, inspects the bearing oil rings, turns on the bearing cooling water, closes the high-pressure oil valves and stops the high-pressure oil pump. The hydraulic operator also inspects the governors to be sure that they are being properly lubricated. After the generator is synchronized, he is usually instructed to run both load-limit cams to their wide-open, or 100 per cent, position as this can be done more readily by hand than by operating the load-limit motors from the benchboard. The hydraulic operator next turns the cooling water on the power transformer associated with the generator, closes the transformer water-alarm switches, and so notifies the switchboard operator after a final inspection of the unit is made and the time of starting is recorded in the hydraulic operation log book.

Switchboard Operator's Duties

After giving the "Start Unit" signal, the switchboard operator closes the transformer high-tension breaker and the voltage regulator master switch. The exciter and field breaker are not opened when the unit is shut down, partly to avoid wear and tear, but principally because it is unnecessary, the exciter armature being mounted on the generator shaft. The field current thus decreases as the unit slows down.

Each generator is under the control of an individual voltage regulator of the extended broad-range type. Each regulator automatically provides both line drop and cross-current compensation and is also associated with a short-circuit protective device.

As the unit and its exciter increase in speed, the exciter voltage increases. When the exciter voltage becomes 80 volts, the generator field rheostat is automatically cut entirely out. The exciter voltage is wholly under the control of the direct-current element of the short-circuit protective device until the generator voltage becomes 55 volts or greater. At 55 volts, which actually corresponds to 5,500 volts on the generator, the control of the voltage is automatically transferred to the vibrating element of the voltage regulator. The generator voltage is then maintained at the value fixed by the voltage-adjusting rheostat. Somewhat in advance of giving the start signal, the voltage adjusting rheostat is set to give the approximate voltage necessary for synchronizing. It will be noted that the generator voltage is completely under the control of the voltage regulator from the instant of starting, which is a decided advantage, since the switchboard operator is relieved of this detail.

Synchronizing the Unit

When the frequency increases to approximately 57 cycles, as indicated by the frequency meter, the synchroscope is connected by inserting the synchronizing plug. Synchronizing is usually done through the unit's transformer, in which case the transformer high-tension breaker is closed immediately after sounding the start signal. Synchronizing is done with an 11,000-volt circuit breaker. The generator may be paralleled directly on the station service bus, if desired. Great care is taken to make good "shots," but owing to the high inherent combined reactance of the generator and transformer, a total of 38 per cent, slight voltage or phase differences do not result in noticeable disturbances. An auxiliary relay operated by a pallet switch on the generator breaker closes when the generator breaker closes, and parallels the voltage regulator's line-drop compensator. The voltage regulators function in a satisfactory manner; in fact, operation would be difficult without them. After being synchronized, the unit is loaded as conditions may require by operating the governor's synchronizing motors, it being understood that the load limit cams have previously been advanced to the full-load position. The regulator is also adjusted after synchronizing, to maintain the desired field current on the generator paralleled.

Units are regularly stopped by use of braking nozzles. These are small nozzles, there being one for each wheel so placed that their jets impinge on the backs of the main buckets.

The braking nozzles are hydraulically controlled by penstock pressure by an ordinary four-way valve operated from a standard near the generator. By using the braking nozzles, units may be stopped in 3 min., where without them the unit will revolve for approximately 50 min. with the field connected to its exciter.

The penstock valves provided for admitting water to the nozzle bodies are normally open, being closed only when work is to be done on the unit. The penstocks are over a mile long and have butterfly valves in their top ends near the surge tank for use in emergency and when it is desired to drain the penstocks. These valves are arranged for remote control from the power house, but as a matter of safety cannot be opened by remote control.

A Challenge to Refrigerating Designers

A Critical Examination of Present-Day Ammonia Condensers—All Are Found Faulty and a Better Design is Predicted

By H. J. MACINTIRE
Assistant Professor of Refrigeration, University of Illinois

The pipe condensers are things of the past but I do not accept the present shell and tube as final. Designers must evolve a condenser more efficient and less costly than the present type.

H. J. Macintire

IN THE refrigerating industry there is probably no division as important and as unsatisfactory in its development as is the condenser. Unfortunately, it has not received the same attention as has the machined portions of the plant.

The compressor has been improved to a high degree of perfection, with regard not only to the valves and the reciprocating mechanism, but also to the lubrication problem, the control of the heat developed during compression and the ability to increase the speed of the compressor to rotative speeds of from 300 to 600 r.p.m.

The same degree of perfection cannot be said to apply to condensers. The condenser is subject to oil accumulation on the inside and scale or other foreign solid material accumulation on the outside of the ammonia pipe. If air or other non-condensable gas exists anywhere in the refrigeration cycle, it finally settles in the condenser or the liquid receiver. The condenser is subjected to superheated vapor as well as liquid accumulation, thereby making parts of the surface non-effective or of no value at all. But worst of all, until very recent years the refrigerating engineer has been obsessed with the one idea of safety, and the result has been a pipe condenser of one sort or another.

In the early days of refrigeration it was natural that engineers should resort to pipe and fittings to build up a condenser, as they considered it comparatively simple to make such a device tight against gas leaks and, even more important, safe against failure. The first was the submerged condenser, where the coils of pipe were submerged in a tank of water, followed by the so-called atmospheric types, consisting of flat coils made up of full-length pipe and suitable common and split return bends. The gas enters at one end and progresses successively through the different pipes until finally it leaves at the other end as a liquid. This condenser is in substance just a long pipe, in which the condensate has to flow with the uncondensed vapor until it finally frees itself from the pipe coil. It is evident, then, that part of the cross-sectional area is filled with liquid and therefore a portion of the surface is not directly exposed to the vapor during liquefaction.

A consideration that has been a talking point for some time, has been the counterflow principle for the ammonia vapor and the condensing water. The feeling has prevailed that the best effect can be obtained by having such a design, both from the standpoint of being a means of obtaining a greater average temperature difference between the vapor and the water and also in regard to getting a cooler temperature of liquefaction or a cooler temperature of liquid leaving the condenser. Neither of these contentions is verified by experiment in either the double pipe, shown in Fig. 1, or the bleeder-type atmospheric condenser. The temperatures of the liquid condensate in both are seldom colder than one degree F. below the temperature of saturation, and often in the experiments of the writer they have been the same as the temperature of saturation.

Respecting the mean temperature difference, as the temperature of saturation remains constant throughout

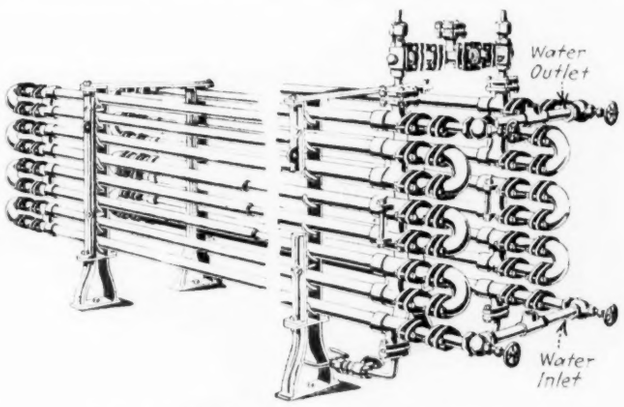


Fig. 1—Typical double-pipe condenser

the greater part of the condenser, it does not appear worthy of any comment whether the vapor and the water are flowing in opposite directions or in the same direction. The only factor of any considerable importance is the velocities of the water and vapor.

Another fallacy that has appeared in condenser design and that has tended to confuse engineers is that called the "flooded" type of condenser, illustrated in Fig. 2. This is a device whereby the compressed gas from the compressor is made to pick up some liquid ammonia in a mixing nozzle and the mixture then passes through the condenser. The basic principle underlying the design is that an intimate vapor and liquid permit a quicker and more efficient heat transfer than would be possible with the vapor without the liquid. However, in, say, the atmospheric flooded condenser it is doubtful

whether the mixture continues for more than a few feet before it disappears and the vapor occupies the upper part of the pipe.

In addition the point that the heat transfer is better from the metal walls to the liquid and then from the liquid to the vapor than between the metal walls and the vapor, is contrary to theory, and it has been shown to be true by experiment. In tests on steam surface condensers it has been found that heat transfer is almost infinite, provided the heat-transfer surface is free of air or liquid. It has been found by other experiments that a layer of inert liquid or air or other non-condensable gas 0.01 in. thick will decrease the rate of heat transfer to about one per cent of the amount that would be obtained if the surface was exposed to pure conduction only. From this consideration a condenser should be designed so as to free itself of the liquid condensate as quickly as possible.

For some time the statement has been current that piping is the cheapest item in calculating the cost of the refrigerating plant, and this has been applied to the condenser. The result has been that some atmospheric condensers have been made 30 pipes high, especially in Great Britain, where they depended on a sort of cooling-tower effect to cool the water also. As time went on, the stands in the United States were reduced to 24, 18 and finally to 12 pipes. Research along this line has developed that 50 to 65 per cent of all liquefaction occurs in the pair of pipes exposed to the coldest water. In the bleeder type of atmospheric condenser this 50 per cent or more of the vapor must travel 200 ft. or more of condenser piping in order to be condensed in the last two pipes.

In the double-pipe condenser similar research developed that about 50 per cent of all liquefaction occurs

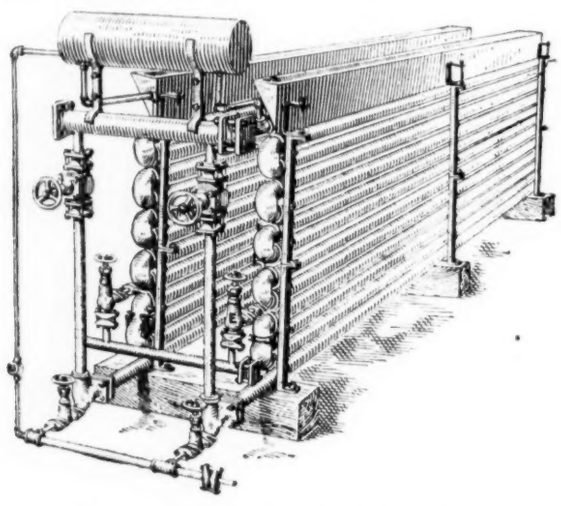


Fig. 2—Layout of a flooded condenser

in the bottom pair of pipes and the gas travels as before through 10 pipes in order to reach the bottom pair. It seems, therefore, that such a design is faulty. There does not appear to be any justification for a design of a double-pipe condenser, involving complicated fittings, at least one flanged joint per pipe—unless the condenser is welded, and elaborate packing around the water pipe. Such liquefaction as occurs in the upper part of the condenser will follow through the pipes, one after the other, until the final exit is reached. Under heavy suction pressures the lower pipes must necessarily work in a very nearly flooded condition, but at any rate the entire surface cannot be effective.

It has been said that a great factor of importance in the double-pipe condenser is the ability to force the condenser by pumping more and more water through it and thereby increasing the velocity of the water in the inner pipe. Yet with the maximum volume possible, the coefficient of heat transfer in the double-pipe condenser does not equal the maximum values obtained in the bleeder atmospheric condenser in tests performed by the writer. In both these types of condensers a large amount of the surface, from three to six pipes, is practically non-effective from the viewpoint of being excess surface. The excuse that might be offered is that fouling of the surface or excessively heavy suction pressures create a demand for the excess area.

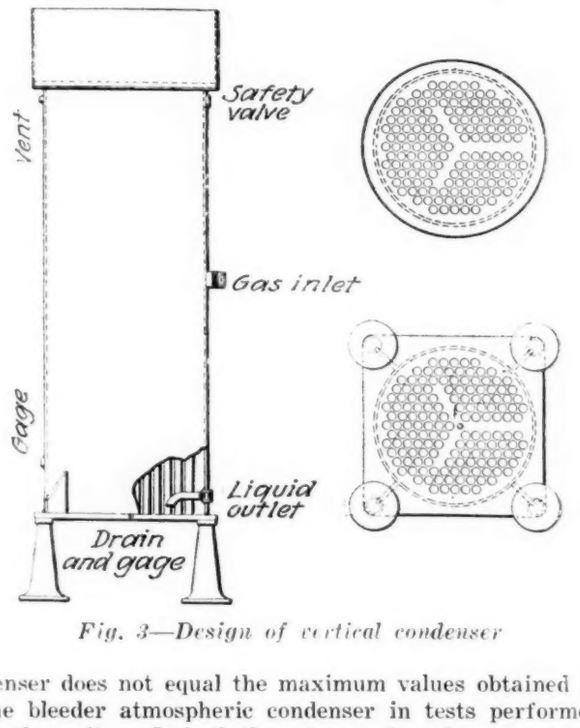


Fig. 3—Design of vertical condenser

The most recent type of condenser, and one requiring considerable courage on the part of the manufacturers, is the shell-and-tube design, of which the vertical type, Fig. 3, is the only one needing consideration. The design eliminates nearly all the objections to the pipe condenser. It does not have an unforgivable mass of valves and fittings; the path of the water and ammonia is short; it frees the tubes of surface films easily; it does not have any non-effective surface due to an accumulation of liquid on the surface, and the value of the coefficient of heat transfer is moderately high. The water velocity in the tubes is relatively small, but it is higher than in the case of the atmospheric types at all times. A well designed distributor will keep all but a very small amount of the water on the surface even in 16-ft. condensers. Still more important, the gas leaks are small in amount and the surface is very self-contained, especially in the larger sizes.

The writer has a feeling, however, that the ultimate condenser has not been developed. He feels that the pipe condensers are practically a thing of the past, but he does not accept the shell-and-tube of the present design as final. Nor is he willing at present to predict that the future condenser will resemble the water-tube boiler as opposed to the present shell-and-tube condenser, which resembles the fire-tube boiler.

Corn Products Plants Cut Costs

By Heat Balance Study*

By J. J. MERRILL†

A SUMMARY of the problems encountered in reducing the coal consumption, together with the operating and maintenance costs in the four factories of this company located in the United States. There are seven other factories: Two in Canada and one each in England, France, Germany, Italy and Holland.

THE boiler plants contained numerous types of boilers; as many as five different kinds and sizes were to be found in one plant. There were hand-fired grates, downdraft grates, overfeed, underfeed and chain grates. In each plant there were some hand-fired grates, as the management at that time did not consider that the frequent heavy fluctuations in the steam demand could be handled with stoker-fired boilers. Coal and ashes were handled manually, and it was thought necessary to carry two and, in some cases, three different steam pressures varying from 90 to 150 lb. The only knowledge the operating man had regarding his heat balance was the weight of the cars of coal unloaded each day, the steam pressure, and sometimes an indicating thermometer to show the feed-water temperature.

Efficient Production Neglected

Little or no thought was given by the men in charge of the factories at that time to efficient production or use of steam and power, the reason being that the managers were the chemists who had developed the business in its infancy. No discredit is intended to the chemist, as he is a necessity in the business and the advance that has been made has been due to a combination of engineers and chemists working together, but each confining his activities to his own field.

In 1907 the production of steam and power and its use in all the factories was put under the complete control of an engineer. It had been discovered that 90 per cent of all the work involved in the manufacture of the product called for engineering rather than chemical knowledge. Today, the managers, superintendents, and master mechanics of the factories are all engineers who have reached these positions by making their start in the boiler house and first learning how to make steam economically, the use of which they eventually were to supervise.

In the early part of the year 1907 the daily coal consumption of what was then the largest plant, was reduced from 600 to 425 tons per day within a period of less than three months and at a cost of less than $500. This saving of 175 tons of coal per day was brought about almost entirely by stopping the waste of steam in the manufacturing departments. This and many other like instances brought about the change from chemist to engineering management.

During this same year, 1907, scales for weighing the coal, meters to measure the water, CO_2 machines, flue-gas and feed-water thermometers, draft gages, and the necessary equipment for coal and ash analyses were installed in each factory and a young engineer with a technical education hired to operate this apparatus and make out daily boiler-house performance reports. Analyses of coal were made in the chemical laboratory and reported to the engineer in charge of the boiler house.

The cleaning of boilers was put on a schedule, the old leaky baffles were removed and poured monolithic baffles put in their place and the boiler settings all put in as good condition as possible without completely rebuilding them. In addition, a great amount of time was expended in teaching the firemen how to handle the fires to obtain good furnace efficiency.

It is impossible to say with accuracy what boiler efficiency was being obtained previous to the installation of the proper measuring apparatus, but it would be a safe guess that it was not above 60 per cent, and more likely 50 per cent would be a nearer estimate.

Reducing the Coal Consumption

During the last six months of 1907 five of the most economical factories operating in the Central West consumed 20.3 tons of coal per 1,000 bu. of corn ground and the boilers operated at an efficiency of 66 per cent. Without any changes in the factories, outside of the boiler houses, with the exception of stopping the high-pressure steam traps from leaking, four of these same plants, in 1908, used on the average 17.6 tons of coal per 1,000 bu. of corn and obtained a boiler efficiency of 69 per cent. Early in 1908 a new boiler house, designed along modern lines with coal and ash-handling equipment and natural-draft chain grates under 5,000-sq.ft. water-tube boilers, reduced the coal consumption to 16.7 tons per 1,000 bu. of corn and completely disproved the old idea that the steam load could not be handled without two or three steam headers of different pressures and the use of hand-fired grates. The reason for this old belief lies in the fact that the factories have a fairly uniform 24-hour process load, coupled with a converter load that is quite variable. Anywhere from two to ten conversions per hour were made with an excessive demand for steam during each period.

In the Kansas City plant three 5,000-sq.ft. boilers, equipped with forced-blast chain grates, average nearly 300 per cent of rating for the 24-hour period. The converter load comes regularly twice every hour of the day, giving a variation each hour in boiler load from a minimum of 200 per cent of rating to a maximum of 360 per cent of rating. The steam load is carried with

*Abstract of paper read before the Midwest Power Conference, Chicago, Feb. 16, 1927.

†Chief engineer, Corn Products Refining Company.

a maximum variation of 20 lb. in the steam pressure and the CO_2 is maintained between 12 and 14 per cent.

In 1926 an average combined boiler and furnace efficiency in all four factories of 74 per cent was obtained, the maximum over-all efficiency at the Kansas City boiler plant being over 85 per cent when credit is given to the boilers for heat removed from the flue gases for drying work in another department.

Comparison of Steam Costs

A comparison of steam costs in 1907, 1912 and 1926 will show the progress that has been made during the twenty-year period. The cost of coal and freight to make 1,000 lb. of steam in 1907 was 12c., the cost of labor 3c.; in 1912 the costs in the same order were 11 and 2c. and in 1926 16 and 2.8c. Basing all three on the cost of coal and labor in 1907, the following comparisons are obtained, respectively: 12 and 3, 10.5 and 2, 9 and 0.95c.

In 1926 the four factories ground 39,000,000 bu. of corn and burned 485,000 tons of coal, giving an average of 12.4 tons per 1,000 bu. Had this amount of corn been ground with the 1907 plant costs, the 1926 coal bill would have been increased $900,000. This has been accomplished in spite of the fact that in 1926, as compared to 1907, the company operated can-making plants which made 8,000,000 cans of various sizes per month, oil plants refining 2,800,000 lb. of corn oil per month, cere-lose sugar plants making as high as 9,000,000 lb. of sugar per month, and many other products in lesser quantities, none of which were made in 1907 and all of which require additional steam and power.

Beginning with 1909, the heat balance of each factory was made, and since then a reduction in the coal consumption has been distributed over not only the power plants, but the manufacturing departments in the entire factory.

High Steam Consumption

The old-time engine rooms had one or more engines belted to a generator supplying electric light for the factory, and in some cases sufficient current to drive the machinery, or if the generators supplied only a part of it, the remainder was obtained through either ropes or belts from a number of engines of various makes and sizes distributed at more or less advantageous points throughout the factory, one factory having twenty-one such engines. The steam consumption of a great number of small units being high, there was always at that time a surplus of lower-pressure steam exhausted to the atmosphere. To pump the large quantities of water needed for condensing vapor from evaporators and for process purposes, direct-acting steam pumps were distributed all over the factory. These were large steam consumers and added to the low-pressure steam losses.

Today, all the electrical generating units and the main water-pumping units are located centrally in the engine room. The electric current is generated either by steam turbines or by steam engines directly connected to generators, and the pumping units are of the centrifugal type directly connected to either motors or steam turbines.

In the design of a new plant or a department of one of them, the engineers are told what products are to be made and the quantity of each. The heat balance is made covering the manufacture of these products, and the process departments are designed to conform to this heat balance. The power house is designed to supply this heat in the most economical way, taking the entire factory into consideration. Whether steam turbines, engines or motors are to be used to drive the machinery is determined by the requirements for low-pressure steam. The units are chosen so that at no time will more steam pass through them than is required by the manufacturing departments, the prime mover being regarded in reality as a reducing valve. This centralization has had much to do with the reduction of the coal consumption. Twenty years ago the company used 1,600 kw.-hr. and 265,000 lb. of steam for every 1,000 bu. of corn ground. Today, in a plant manufacturing the same product, the requirements are 2,800 kw.-hr., but only 137,000 lb. of steam, per 1,000 bu. of corn.

How Heat Balance Was Improved

Improvement in the heat balance has been made by more efficient operation of the original apparatus, by substitution of more efficient equipment in many instances of increasing unit size, and by using heat that formerly was discharged to the atmosphere or the sewer. It is in the case last named that heat problems of the greatest interest have been found and an interchange effected to conserve all available heat. In the paper numerous cases were cited.

In the feed department other large savings have been made in the drying of the product by improvements in the type of drier, a change from the use of steam to direct firing, and eventually, in the Kansas City plant, by the use of the flue gases as they leave the boiler. When operating at a rating of 280 per cent with no superheaters and carrying 225 lb. steam pressure, the gases leave the boilers at an average of 660 deg. and pass out of the driers at an average temperature of 130 deg., giving a greater over-all economy than could be obtained in any other way. The consumption of coal chargeable to these driers is 2½ lb. per bushed of corn ground as compared to 40 lb. of steam, or 6 lb. of coal burned under the boilers with the old type of steam driers.

Making a comparison of the equipment required to do the drying of feed from the 39,000,000 bu. of corn ground in 1926 with that which would have been to do the same amount of work in 1907, today 21 driers are used as compared to 114 that would have been required of the earlier type with a saving of $200,000 per year in the coal bill.

Determining Cost of Product

The heat balance of each factory is now made so that it is perpetual and is used to determine the exact coal cost for each product made. Each production department is charged with all the heat entering it, whether it is coal used directly, kilowatts, steam, hot water, or heat in the product received from some other department. These charges are all reduced to B.t.u., and each department is given credit for all heat that is delivered by it to another department, it being charged with the heat actually used or lost to the sewer. The necessary meters and other apparatus are installed in each department to measure this heat, and a daily report made showing the amount of steam, water, kilowatt-hours, etc., going to each department. From these reports, at the end of each month, the B.t.u. charge against each department is made and the percentage of the total B.t.u. to each department computed. The

percentage of heat consumption in each department indicates the percentage of the total coal used by this department, and this amount is charged to the department plus its share of the coal used by the non-productive departments such as the boiler house, engine room, offices, shops, storerooms, etc. The heat used by these latter departments, while in most cases measured, does not directly enter the final figures because it is automatically prorated over the production departments in exact proportion to their heat consumption.

By placing an assistant to the chief engineer of the company in charge of the maintenance work in all factories in 1912, a considerable saving has been effected. During the following year, 1913, the average maintenance in all the factories was 2.75c. per bushel of corn ground. In 1926 the maintenance cost was 2.7c. In 1926 labor costs were 83½ per cent higher and material cost 117 per cent more than in 1913. Based on the 1913 labor and material costs, maintenance in 1926 would have been 1.2c. per bushel of corn ground, a reduction of over 1½c. per bushel, amounting to $585,000 per year.

Much of the good work that has been established has been due, to a great extent, to the way the engineering department is organized. There is a designing department where an entire factory or any part of one, is designed in its entirety; a construction department which does all the construction work, there being no outside contractors employed on any work; the operating department which takes over and operates the plant when it is ready, and the maintenance department. Each of these departments has an engineer in charge of it, who has grown up in the business.

The chief engineer, who is responsible for all these departments, is also chairman of the Manufacturing Committee, which controls everything having to do with the manufacture of all the products.

How Electric Circuits Are Opened by Circuit Breakers

By BURT S. BURKE
Switchboard Engineer, Westinghouse Electric and Manufacturing Company

OPENING an electric circuit with an automatic circuit breaker involves more than is generally appreciated. This article explains how a circuit is interrupted by an air-break circuit breaker and by an oil switch.

SINCE the air-break circuit breaker was the first developed, it will be considered first. The current-carrying parts of a modern air circuit breaker, exclusive of the contactor class, consist generally of a main current-carrying contact and an arcing contact with one or two sets of intermediate contacts. The main contacts consist of two copper studs *D* bridged by a moving contact *A* which in most cases is made up from a number of copper laminations. This type of contact has a wiping action as the breaker closes, which insures a clean contact surface and thus a low contact drop. The arcing contacts *C* consist of two blocks of carbon, one of which is stationary, and the other is mounted on the moving arm of the breaker. The intermediate contacts *B* are of copper and perform the function of gradually shunting the current from the main contacts to the arcing contacts when the breaker opens.

When the breaker opens, the main contacts part first, and since these contacts are shunted by the intermediate and arcing contacts, practically no arcing occurs at this time, and consequently little or no burning of the main contacts results. The current is now carried by the intermediate contacts. The purpose of these is to provide a comparatively low-resistance shunt path for the current in the circuit being opened. This feature gives a gradual transition from the low-resistance main contacts to the comparatively high-resistance arcing contacts. If this transition were made in one step, the voltage across the main contacts at the instant of opening would be much higher, thus causing burning and pitting of the main contacts. After the main contacts open, the intermediate contacts, which consist of either one or two sets, open and shunt the current to the arcing contacts, which now are the only contacts remaining in the circuit.

From the foregoing, it can be seen that as the breaker opens, the current is transferred from one set of contacts to another always in an upward direction, so that

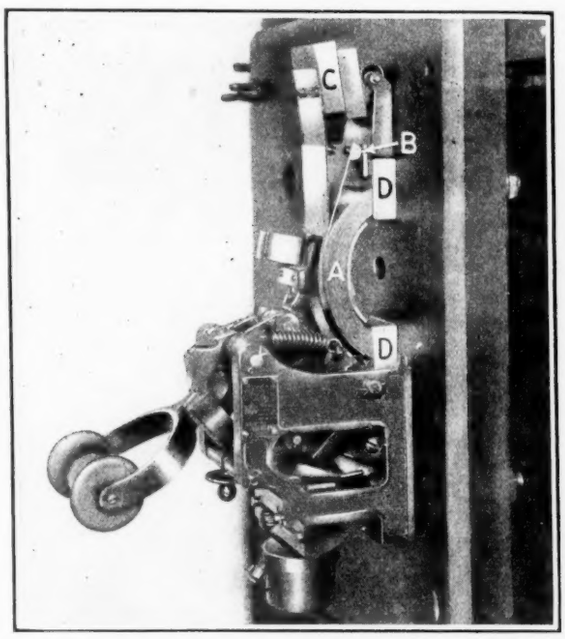


Fig. 1—Standard-type air-break circuit breaker

when the arcing contacts part, the arc is away from all operating parts and unable to damage them. Now, as the arc is formed, some of the arcing contact material is volatilized, thus forming a conducting vapor which tends to sustain the arc. The quantity of this vapor formed depends upon the energy dissipated at the time

of opening the circuit. This in turn depends upon the power concentrated behind the breaker and the time required by the breaker to open and break the arc. The power concentration depends upon the characteristics of the system and must be considered in applying the breaker. The speed of contact separation is a condition involving the design of the breaker and may be controlled within certain limits by accelerating devices. From this it is evident that a circuit breaker should not only open the circuit, but should do so quickly, since the quicker the contacts part the easier the arc is broken.

In the carbon-break circuit breaker the separation of the contacts is wide enough to draw the arc out and break it. In opening a circuit, however, there are two factors that aid in breaking the arc other than the purely physical separation of the contacts. The first of these is the natural tendency of the arc to rise due to the fact that it is at a high temperature and is lighter than the surrounding air.

The second factor is the magnetic blowout effect of the current carrying path. In this case the current comes in one of the studs, goes through the moving contacts and then out through the other stud, thus turning through 180 deg. and forming a loop. Due to the magnetic forces set up by the current in this loop, there is a tendency for the sides to be forced apart. Thus, when the contacts part, the magnetic forces tend to blow the arc up, increasing its effective length and aiding in its cooling. Theoretically, the air circuit breaker might be applied to any voltage by providing a wide enough separation of contacts. In everyday practice, however, mechanical limitations prevent the application of air breakers when the voltage exceeds a certain value (approximately 3,000 volts direct-current).

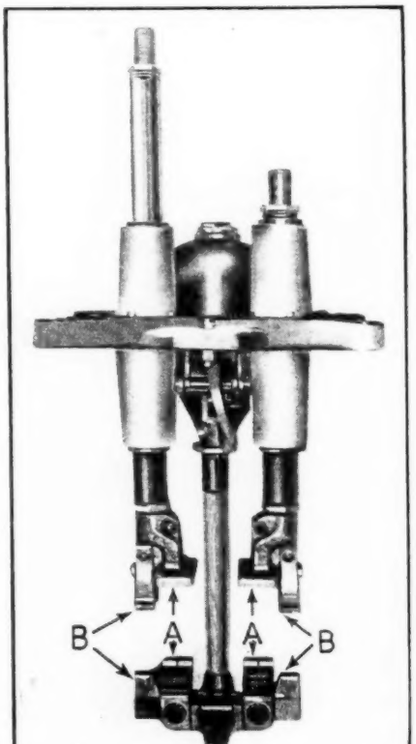


Fig. 2—Contacts for one pole of an oil circuit breaker

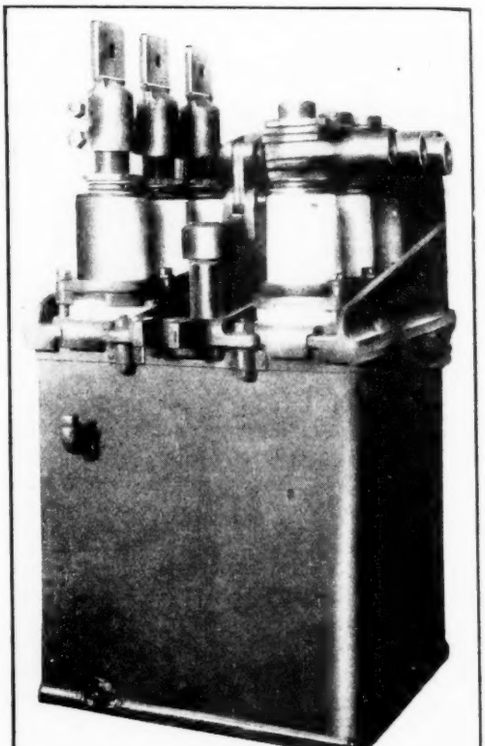


Fig. 3—Three-pole, 2,000-ampere, 60-cycle oil circuit breaker

From the foregoing it is evident that the air breaker ruptures the arc by stretching it out, using the magnetic blowout effect of the current, as well as the natural tendency of the arc to rise, as auxiliary factors to increase the effective length of the arc over the actual physical separation of the contacts. In the oil circuit breaker the same basic principle of lengthening the arc until it ruptures is employed, but the auxiliary factors aiding this action are somewhat different.

When higher voltages—6,600 volts and above—first became common, it was found that some substitute for the air-break circuit breaker would be necessary. By experiment it was discovered that when an alternating-current arc was ruptured in a closed container filled with an insulating oil, the disturbance was much less than when the same arc was ruptured in air. This discovery brought about the development of the oil circuit breaker which is in such general use today. In theory of operation, as has previously been stated, this type of breaker is similar to the air breaker.

Modern oil circuit breakers in general consist of a set of main current-carrying contacts *A*, Fig. 2, and a set of arcing contacts *B*, immersed in a tank of insulating oil, as in Fig. 3. These contacts are opened and closed by means of connecting rods that extend through the top of the tank and are connected to the operating mechanism through a system of levers mounted on the top casting of the breaker.

When a breaker of this type opens, the main contacts part first, the same as for the air circuit breaker. The oil breaker is not provided with intermediate contacts because the arcing contacts in this case are of copper instead of graphite. The current is thus shunted directly from the main contacts to the arcing contacts, which open shortly after the main contacts have parted. The action so far practically parallels that of the air breaker. Now, as the arcing contacts part, the arc is formed and part of the arcing contacts are volatilized, similar to the action of the opening of the air breaker. The oil now enters in to act as a quenching medium. As the arc is formed, part of the oil is carbonized and part of the arcing tip volatilized, thus forming a pocket of gas around the arcing tip. The oil that surrounds this arcing contact, being heavier than the gases formed by the arc and aided by the pressure generated, rushes in, cooling the arc and forcing it away from the contacts until it is finally ruptured.

In the oil breaker as in the air breaker the magnetic blowout principle is also employed. That is, the arcing contacts are located outside the main contacts, so that when the arcing contacts part, the magnetic effect of the current through the U-shaped loop blows the arc out and

away from the main contacts. This protects the main contacts from burning and at the same time lengthens the arc and aids in breaking it.

Perhaps at this point a brief summary of the factors entering into the interruption of an arc by these two types of breakers would be helpful. In the air circuit breaker two primary factors enter into the action, first the speed of opening the contacts, and secondly, the purely physical separation of the contacts. The latter factor is modified by the natural tendency of the arc to rise and the magnetic blowout effect of the current in the circuit. The arc in this type of breaker is opened in air which has a fairly constant dielectric strength, assuming, of course, that this breaker is in a moderately well ventilated room. In the oil circuit breaker practically the same factors enter; that is, the speed of opening the contacts and the physical separation of the contacts. Furthermore, the effective length of arc is increased by the magnetic blowout effect of the current and by the effect of the oil forcing the hot gases away from the arcing tips.

However, in this type of breaker, since the arc is opened under oil, another factor enters. At each interruption the arc decomposes part of the oil in the tank. This action forms minute particles of carbon which eventually settle to the bottom of the tank, but which for some time remain suspended in the oil. Since carbon is a conductor, it is readily seen that the dielectric strength of the oil is lowered by its presence, which in turn lowers the effectiveness of the oil as an insulator and as means of quenching the arc. When an oil circuit breaker is used on alternating-current circuits, this factor is not one to cause a great deal of trouble because the current passes through zero every half-cycle and it is at this point that the arc is interrupted.

When the oil breaker is used on a direct-current circuit, it is a more serious matter. The current does not pass through zero periodically, and hence the breaker must interrupt the full value of the current, which is not done as quickly as is the case with alternating current, with the result that quite an appreciable amount of the oil is carbonized by the arc. This rapidly decreases the dielectric strength of the oil, so that it must be filtered frequently to keep it fit for insulating purposes. This factor constitutes the main objection to the use of oil breakers on direct-current circuits and perhaps explains why these breakers are used almost universally for alternating-current circuits.

The preceding paragraphs have not been written with the idea of discussing all the factors that enter into the opening of an arc by a circuit breaker. These factors are too numerous, especially in the case of oil breakers, and this, in addition to the fact that the most effective method of opening an arc is still open to discussion.

LESS THAN TWO MONTHS REMAIN in which to submit manuscripts for the *Power* Prize Contest. A few have already been received. For the information of those readers who may have missed the previous announcements, it will be reiterated that the prizes are for the *articles showing the most commendable improvement in the results obtained from the modernization, reorganization or improved operation of a power plant during the last two years*. The first prize is $500; second prize, $250; third prize, $100. For the conditions of the contest see announcements in *Power* Feb. 8, Feb. 15, Feb. 22, and Mar. 1, 1927. Further information will be furnished on request.

Supporting Structures for H.R.T. Boilers

At a recent meeting of the American Boiler Manufacturers Association, H. E. Aldrich, of the Wickes Boiler Co., reported for the Committee on Horizontal Return Tubular Boiler Standardization. In discussing this matter, he said that certain values had been agreed upon to cover the design of tubular boiler supporting structures. These values for the columns are a slenderness, or $\frac{L}{r}$, ratio of not over 120. For the girders or supporting beams a maximum stress of 15,000 lb. per sq.in., and for the hanger bolts a maximum stress of 10,000 lb. per sq.in. In the slenderness ratio formula L is the length in inches and r is the least radius of gyration. The value of r for standard cross-sections may be found in the steel companies' handbooks. The value of r may also be found from the equation $ar^2 = I$, where a is the section area and I is the least moment of inertia. There are two values for r (except in a round section) for each cross-section, that is, one taken in each direction about an axis through the center of gravity.

In an I-beam section the value of r about the axis parallel to the flanges is several times the value about the axis running through the web. This shows the comparative strength of an I-beam used as a column against bending in one direction, and its weakness in the opposite direction. In an H-beam section there is some difference in the values of r but it is so much less that it is readily apparent an H-section is more economical and better designed for use as a column.

The Slave of Giants

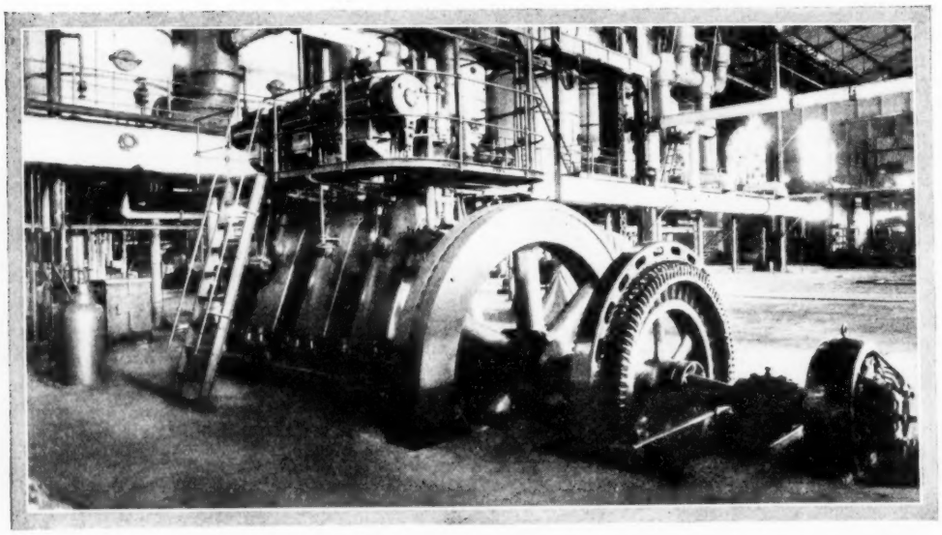
BY J. S. BROWN

I love the roar of an engine room,
With the clangor and whir and busy boom
Of huge rotating things of steel,
And the tons of mass in a single wheel,
The miles of pipe in runs and bends,
And the pleasant drone that never ends.
Then those huge boilers with throbbing heat,
That shudders and roars like a great heart-beat.
It takes a man to love these things;
To sweat and bleed that they may bring
Gifts of light and heat and power
To a waiting world, its rightful dower.

So mighty is this power of steam,
That man's poor effort scarce would seem
Sufficient to control its flow
Into these giants it makes go.
Yet man is master everywhere,
From the firing aisle's bright flaring glare
To the turbine's sensitive safety trips
And the little traps that handle drips.
He knows the size of the boiler drums
And what to do when danger comes,
From a little thing like a leaky seal
Or from overspeed on tons of steel.

There's danger in this mighty place,
Danger that men have trained to face.
These huge things that they create,
That roar and drone and reverberate,
May break and fill the heated air
With missiles that will rend and tear
The work of years in a moment's span,
And in this maelstrom you'll find Man,
Doing his best to save and keep,
Not trying the path of safe retreat.
Oh, yes! Our ends may come too soon,
But I love the roar of an engine room.

American Diesel Engines Dot the Globe



Cuba

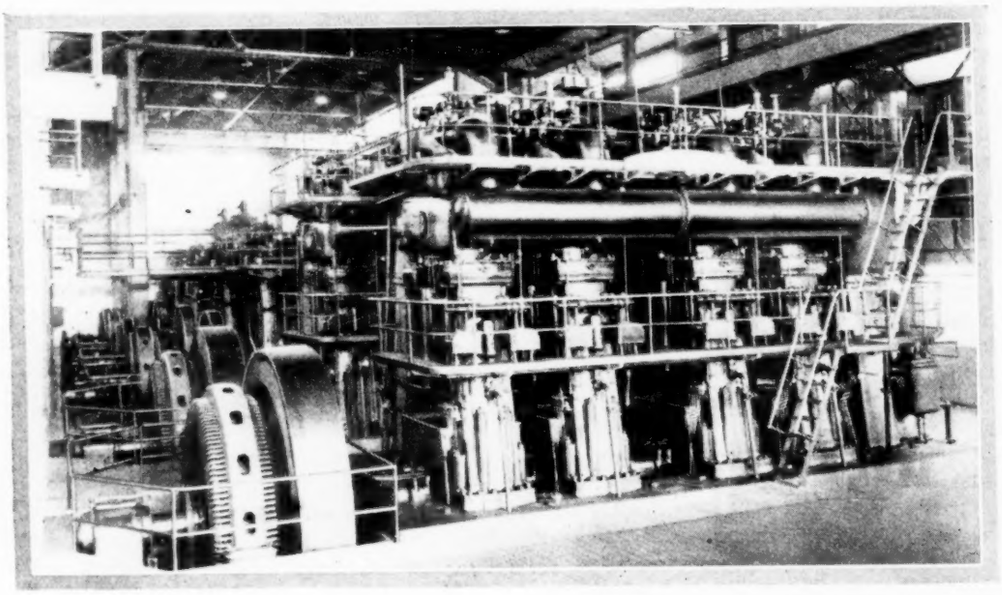
Left — Fulton Diesel engine does its share to satisfy world's sweet tooth at Central Gomez Mena

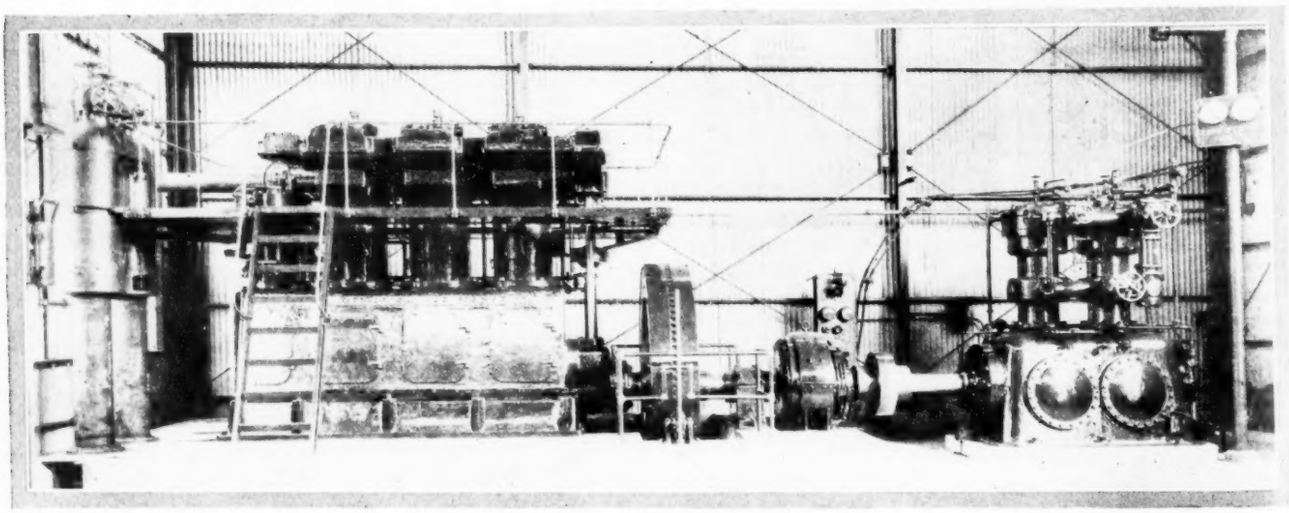
Mexico

Below—Largest Diesel installation in the western hemisphere, installed in the plant of Moctezuma Copper Company, Nocozari, Sonora, consists of six Nordberg engines, two of 2,200 hp. and four of 1,250 hp.

Hawaii

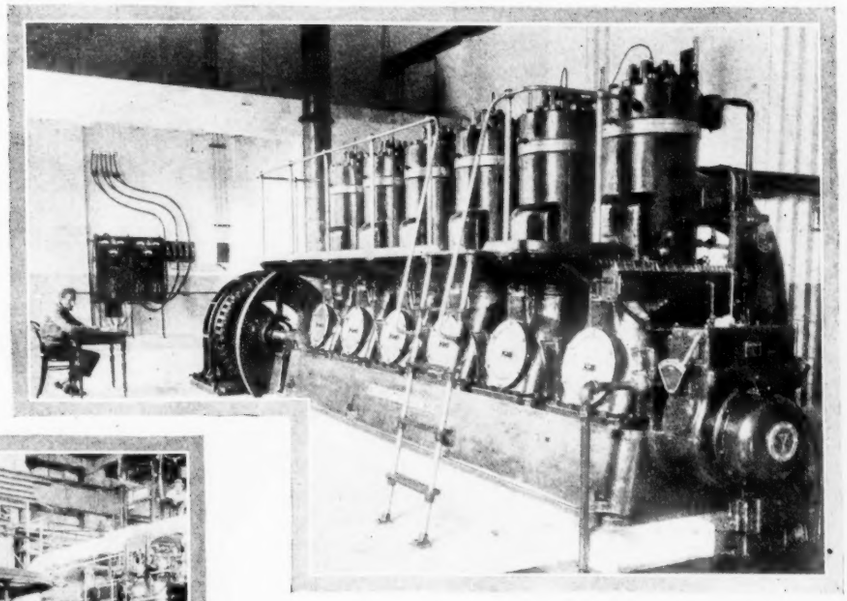
Below — In the home town of soft music and fair weather mundane needs for ice and cold storage are taken care of by a 300-b.hp. Busch-Sulzer Diesel engine direct connected to generator and ammonia compressor. This is in the plant of the Oahu Ice & Cold Storage Company in Honolulu

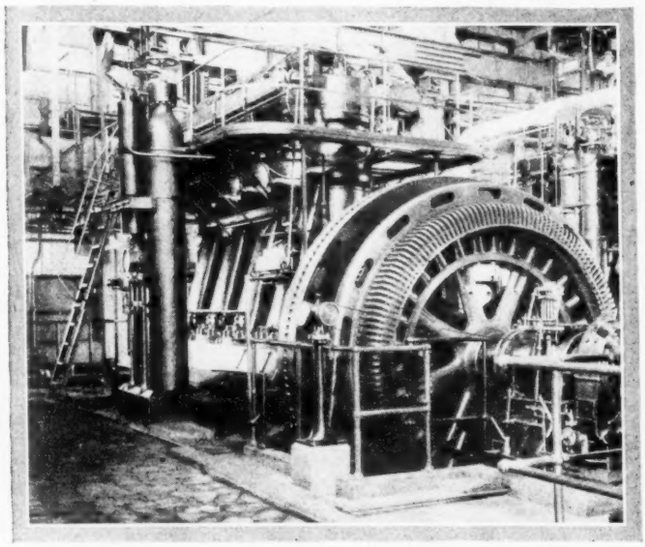




Brazil

Right—Cia Uniao Refinadores (United Refineries Company) in Sao Paulo is served by this 300-kva. Fairbanks Morse Diesel generating set



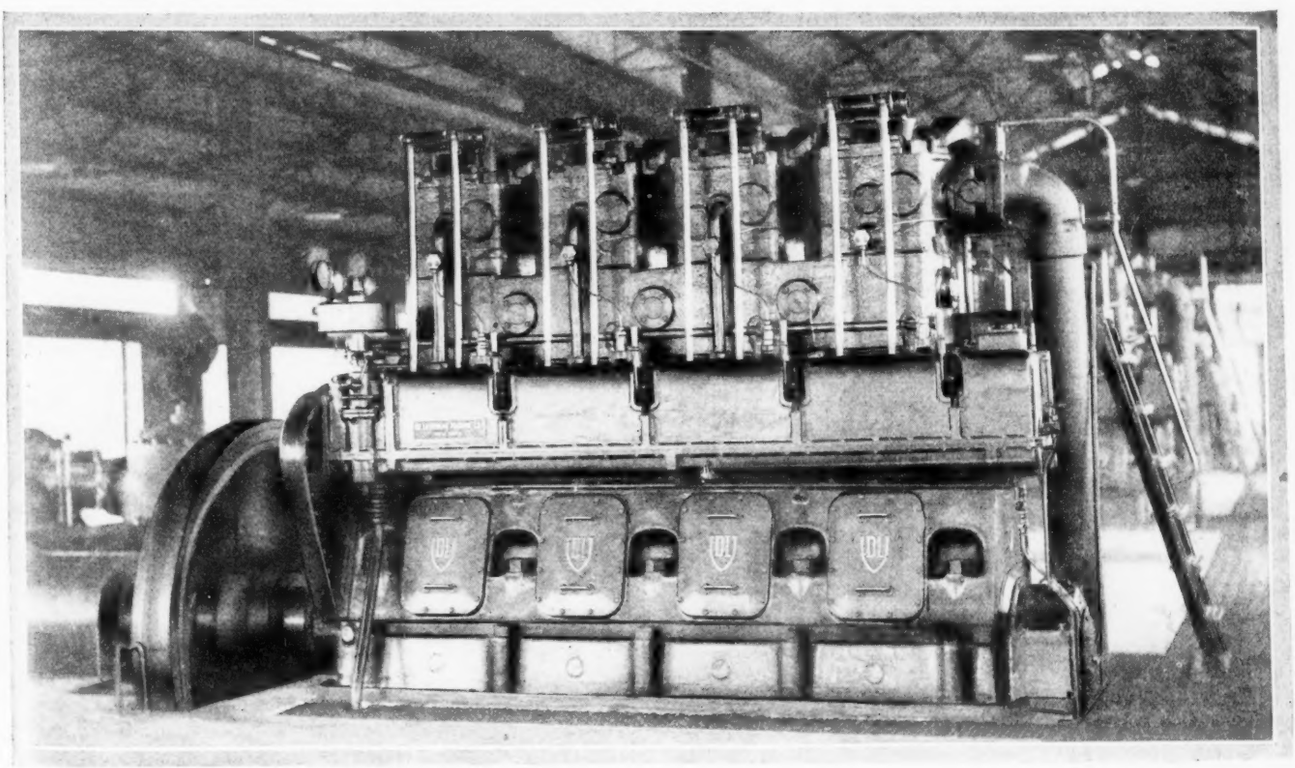


Ecuador

Left—Generator driven by 500-hp. McIntosh & Seymour Diesel engine lights the town of Guayaquil and drives the trolley cars

South America

Below—De La Vergne Diesels like this pump oil in the pipe line stations of the Andean National Corporation



Outwitting the Smoke Inspector

Steam Jets in Boiler Furnaces Eliminate Smoke—Boilers Can Now Carry More Overload—Efficiency Improved

By A. A. FETTE

TURBULENCE in furnaces will undoubtedly be one of the main factors influencing combustion in the boiler plant of the future. In fact, even now a number of engineers have come to realize the importance of turbulence, and I have been forcibly impressed by an experience in our industrial plant.

Last summer we were driving the boilers in order to carry the load, and immediately we had the smoke inspector on our heels, he insisting that something must be done. He instructed us to put steam jets in through the fronts, but because some of the boilers were equipped with side-feed furnaces, the idea did not suit me. In fact, I could not see how jets could be installed through the fronts of such furnaces and finally told the inspector I would put in jets, but they would be installed to my own notion.

After considerable thought I concluded that the jets should have the same direction as the coal feed, and as the inspector became aware of this, he railed and protested against our plan and brought to our attention an ordinance according to which we could not proceed with our alteration without his approval. Finally, after considerable argument between the inspector, the manager and our mechanical director, I was allowed to proceed with my experiment.

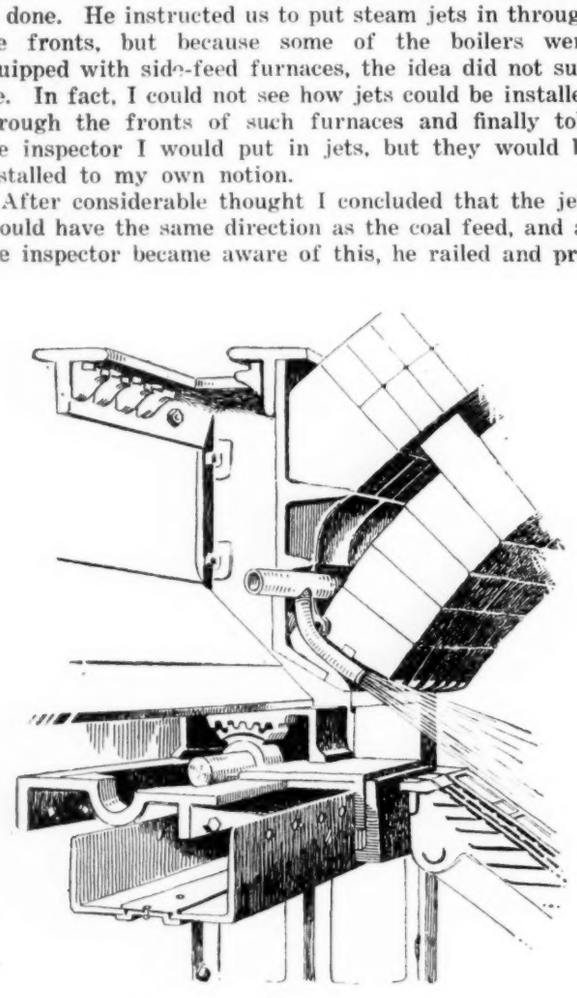


Fig. 1—Location of steam jets

Openings for 1-in. pipes were burned through the fronts with the acetylene torch and a hole punched through the front brick wall in line with the arch plate. Holes were drilled in a 1-in. pipe and tapped for ¼-in. bent nipples spaced one foot apart. Some brick were removed from the side wall in the furnace and the manifold pushed through the combustion chamber, and after reaching the proper location the pipe was given a little turn and the bent nipples dropped down between the fingers of the sectional arch supports, as shown in Fig. 1. The ends of the nipples were left one inch less than flush with the face of the arch sections, and after the proper connections were made in front of the boilers, one boiler was tried out. These manifolds were installed without disturbing the arch of the furnace.

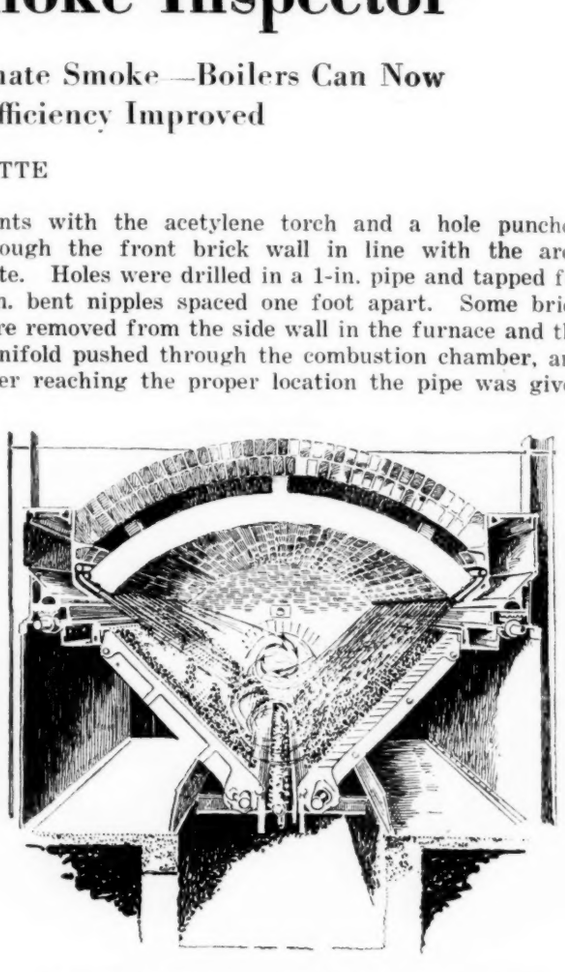


Fig. 2—Turbulence obtained by jet action

Well-Type Principle Used

Having taken part in a number of discussions on combustion, I concluded to try to effect something like the well-type principle, so I directed the jets on one side parallel with the grates and the jets on the other side with a pitch away from the slope of the grates, as shown in Fig. 2.

The surprise came when we put this boiler on the line. We found that we could get a roaring fire somewhat like an oil-fired furnace, which in itself is all turbulence, we could burn about a third more coal than formerly with less agitation and could jump the boiler rating from 135 to 200 per cent and more. The evaporation improved from 8½ lb. per lb. of coal to 10 lb.

It was another case of stumbling on something far better than was expected, and as a consequence all the

other furnaces were similarly equipped. Formerly, when observing the fire with dark glasses it was seen that the gases left the fuel bed and immediately took a direction toward the boiler tubes, the unit being a Wicks vertical water tube. Now, in observing the fire a well-defined turbulent action can be seen. A thorough mixing takes place and the gases flow on toward the boiler somewhat similar to a corkscrew. In these inclined-grate furnaces a large amount of the volatile matter distilled off as soon as the coal enters the furnace, takes a direction toward the combustion chamber. With these steam jets all this volatile matter is driven down and whirled around in the most incandescent zone and a proper mixing of the gases takes place before passing on to the combustion chamber.

We have gas collecting tanks on each boiler and analyze the flue gas every 24 hours. Previously, we

EVAPORATION BEFORE AND AFTER INSTALLATION OF JETS

June 23	7	Feb. 22	9.98
June 23	9.2	Feb. 22	8.94
June 23	8.2	Feb. 22	9.98
June 23	7.7	Feb. 22	8.74
June 23	8.7	Feb. 22	8.84
June 23	8.0	Feb. 22	8.74
June 24	8.0	Feb. 23	9.36
June 24	10.4	Feb. 23	9.15
June 24	8.0	Feb. 23	9.67
June 24	8.5	Feb. 23	9.57
June 24	8.0	Feb. 23	8.74
June 24	7.9	Feb. 23	8.63
June 25	8.3	Feb. 24	9.57
June 25	8.0	Feb. 24	9.36
June 25	8.1	Feb. 24	9.67
June 25	7.4	Feb. 24	9.78
June 25	8.4	Feb. 24	9.26
June 25	7.5	Feb. 24	9.05
June 26	7.5	Feb. 25	9.46
June 26	7.7	Feb. 25	9.36
June 26	8.1	Feb. 25	9.05
June 26	7.6	Feb. 25	9.36
June 26	9.6	Feb. 25	9.15
June 26	7.8	Feb. 25	9.67

8.1 lb. average evaporation on Murphy furnaces 4 days before steam jets were installed.
9.33 lb. average evaporation on Murphy furnaces 4 days after last steam jets were installed.
Four Murphy furnaces. Flow meters read every 8 hours. Coal weights for every 8 hours.
It took from July to February to install all the jets, as boilers were always in service and only occasionally a chance presented itself to install one side at a time.

always secured the best CO_2 with the underfeed stokers which registered 12 per cent or better, quite good for an average of 24 hours. This percentage was usually 2 or 3 per cent better than we could get from the side-feed furnaces, but since the jets are operating we secure the best CO_2 with the latter.

While we have six boilers, most of the time we operate with five of them. The total heating surface of the five boilers is 17,000 sq.ft. Previously, the best we could get with the five boilers was 176 per cent rating on total output, but on Feb. 8 of this year we operated three-quarters of an hour at 235 per cent rating. From this it may be noted that we increased the capacity of the boilers nearly 25 per cent by the use of the jets.

Stratification of Gases Eliminated

Stratification, another objectionable feature in combustion, has been eliminated, and possibly this has considerable influence on the improvement. It may be readily understood that with the thorough mixing, stratification of the gases has been eliminated.

The conclusions as to this experiment have not been arrived at hurriedly, but rather after numerous adjustments and tests. It is now about nine months since the first furnace was equipped.

The steam nozzles in the original installation were full-sized pipe, but in a later installation we tried to obtain a spray effect by flattening the ends of the nozzles. From our experiments we have found that the full-sized pipe is the most effective in securing the results we desire.

The firemen have found that by manipulating the regulating valve even better results can be obtained than were noticed at first. When the fire is heavy they turn on more steam, and as the fire burns down they choke the steam down a little more, but as long as the boilers are operating some steam is used.

Lubrication of Elevator Guide Rails

THE guide rails of elevators should be kept well lubricated. Lack of lubrication causes noisy operation of the car and excessive wear on the guide shoes and rails. When the guide rails are not properly lubricated, it is not uncommon when riding in the car to feel the guide shoes seize the rails, and this not only causes noise, but gives the car an unpleasant motion.

The old method of lubricating the guide rails was to have them painted with a heavy grease or oil by someone riding on top of the car. This required taking the car out of service, was a dangerous and disagreeable job and took considerable time to do properly. For these reasons lubrication of this part of the elevator was frequently neglected, causing undue wear of the guide shoes, unpleasant riding in the car and increased power consumption.

To ride on top of a car even with both hands free is not desirable, but to do this with a grease pot in one hand and a brush in the other is a hazardous job. Another objection to hand lubrication is that it is either a feast or a famine of oil on the guide rails. If they happen to be properly lubricated after the job is first done, the lubricant immediately begins to decrease and is not renewed until there is a deficiency or an entire absence of oil. In other words the lubricating is done intermittently when it should be done continuously and the oil should be applied in small quantities. If a heavy lubricant that sticks to the rails is used, the dust that falls on the rails remains in the lubricant and is only pushed off beyond the reach of the guide shoes to have probably a large part of it brushed back on again at the next greasing. To prevent this, in some cases the rails are washed down with kerosene at intervals, but this greatly increases labor costs, is a hazardous job, and can be done only by taking the car out of service. Washing the guide rails down is by no means a common practice.

Automatic Lubrication

Automatic guide-rail lubricators are coming into general use. These devices may be divided into two general classes—those that are stationary and are mounted on the top ends of the guide rails or in the penthouse, and those that are mounted on the top guide shoes and travel with the car.

A stationary-type automatic guide-rail lubricator, made by the Atlas Elevator Devices Co., is shown in Figs. 1 and 3. It consists of a reservoir from which the oil is fed continuously by three wicks to the three sides of the guide rail. A spring *A* passes down the center of a tube and comes out on the guide rail as indicated at *B*, there being three tubes, one for each side of the guide rail. About halfway down each spring is a

loop *C* through which the wick passes and doubles back into oil in the reservoir. One of the springs with its wick is shown in Fig. 2.

The amount of oil fed to the guide rails is controlled by the number of wicks looped through the spring. This in turn is controlled by the number of floors the car travels. As a general rule, up to 4 floors one loop of wick is used; from 5 to 9 floors, two loops; 10 to 14 floors, three loops; 15 to 20 floors, four loops; and over 20 floors, five loops.

It is preferable that a medium grade of oil, having a viscosity of about 270 to 290 and a flash point greater than 390 deg. F., be used in the lubricators, distributed to the three sides of the rail by gravity and with the assistance of the guide shoes. The oil tends to work to the lower ends of the guide rails and carries with it the dust and dirt that may accumulate on the rails, and assists in keeping the guide surfaces of the rails clean.

One of the most desirable methods of installing these lubricators is on the top end of the guide rails, as in Fig. 1, after they have been extended up into the pent house. If not installed in this manner, they may be mounted on a short section of guide rail in the pent house, as in Fig. 3, and the lubricating tubes with their springs extended down to the top ends of the guide rails as shown in the figure. When installed in the pent house, the attendant does not have to go on top of the car to lubricate the guide rails. The reservoirs are where they can be inspected by the attendant when on his regular inspection trips. This is pretty good insurance that they will be kept filled and the rails assured of a constant supply of lubricant. As the reservoirs have an oil capacity from two to four weeks' service, there is little reason for their going dry, except through inexcusable neglect.

The first types of guide rail lubricators were mounted on the guide shoes and were attempts to duplicate the idea of the hand method of painting the oil on with a brush. The oil was carried in a reservoir and distributed to the rail with a large wick, one end of which was in the oil and the other end was intended to rub on the rail continuously. A later type pumps the oil from the reservoir. The pump is operated by a lever that strikes a pin at the top ends of the guide rails, as the car approaches the top landings. With these types of lubricators the attendant must go on top of the car to inspect and fill them. If they are neglected and the rails become dry, they are likely to be injured by rubbing on the dry rails.

Guide-shoe linings are frequently made with their rubbing surface parallel, for their whole length, with the guide rails as in Fig. 4. With such construction the sharp edges of the shoes tend to scrape the oil off the rails and make it difficult to lubricate them properly if the shoes make a good fit. The idea of forming a wedge of lubricant between the surfaces to be lubricated has proved to be one of the most successful methods. It has been found by experience that this method also works successfully when applied to guide shoes, by beveling the top and bottom edges of the linings as in Fig. 5. The lubricant collects in this space and is pulled in between the shoes' surfaces and the rail.

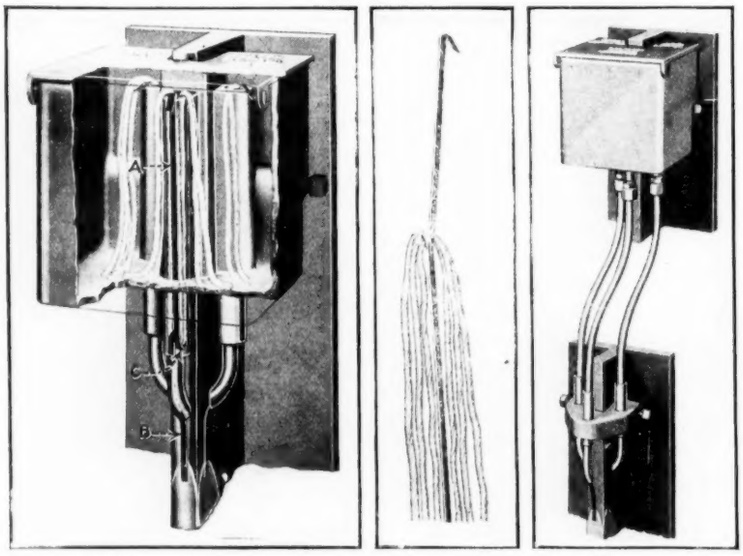


Fig. 1 (Left)—Section through stationary-type lubricator. Fig. 2 (Center)—Lubricator spring with three loops of wick. Fig. 3 (Right)—Extension type, for rails not extended into pent house

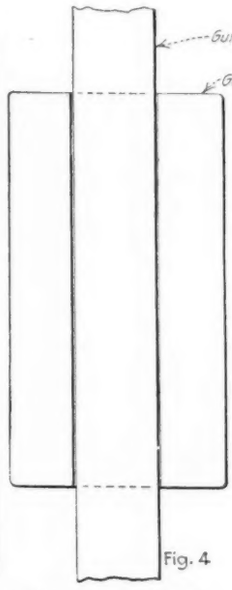


Fig. 4—Guide shoe without beveled lining

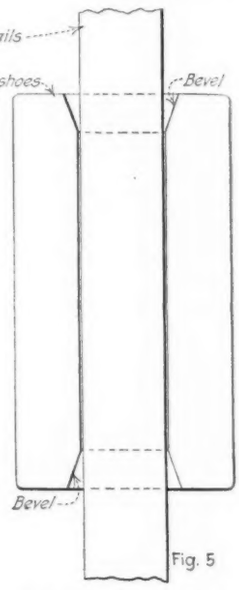


Fig. 5—Guide-shoe lining beveled top and bottom

PHENOLPHTHALEIN, although it turns pink, cannot be depended upon as indicating the presence of ammonia in brine. The action is due to the alkalinity of ammonia, and it is possible that the brine itself may be slightly alkaline. For this reason, in testing, the phenolphtalein drops should be replaced by a phenolphthalein paper or litmus paper. Instead of immersing the paper in the suspected brine, a drinking glass should be half filled with the brine and a small amount of caustic soda added. After allowing sufficient time for the caustic soda to dissolve, the glass should be covered by a strip of glass to the underside of which is attached a piece of litmus paper moistened at the ends to cause it to adhere. If the brine contains ammonia, the paper will be turned pink by the action of the ammonia fumes. Warming the brine will hasten the action. If the paper is not affected after four or five minutes, the brine contains no ammonia. The amount of ammonia can be approximated by time elapsing before the paper changes color.

Keep a Record

YOU think your plant is efficient; do you know? Is it as efficient as it might be? Is it efficient financially as well as in heat units? How can you tell if you keep no records of coal burned, water evaporated, etc.? Even if nature equipped you with some strange clairvoyant power by which you can tell instinctively that everything is thus and so, how can you convince the manager if you have no records?

Suppose Jim Smith wastes steam in manufacturing department A. Will you be on the defensive when confronted with the larger coal bill, or will your records show that you use less coal than ever per thousand pounds of steam produced? It is hard to find a leg to stand on for the man who opposes or neglects records in these days of reliable instruments for everything worth measuring.

Impurities in Steam

WONDER has often been expressed at the amount of material that finds its way from the boiler through the superheater to the steam main and connected apparatus. Putty-like masses occur at times in the clearances and passages of reciprocating engines, but attention was forcibly called to the presence of such material when the turbine came into use, by its deposit upon the blades.

There is a general impression that the dissolved impurities are thrown down when the water is evaporated and remain in the boiler, only steam with perhaps some entrained distilled water going out through the stop valve. If the water carried over by priming, foaming or entrainment did contain some foreign matter, it was supposed that this would be left in the superheater when the final evaporation took place.

This would be the case if the system were in a state of quiescence or gentle activity, but the conditions inside a modern boiler are quite otherwise. A mass of water, containing precipitates and chemicals in suspension and solution often to a considerable degree of concentration, is in a state of violent ebullition and rapid circulation. The current of steam passing out the discharge nozzle and through the connected piping with a velocity more than, sometimes nearly triple, that of a seventy-five-mile gale, carries these impurities not only out of the boiler, but through the superheater and into the system.

The high rates of evaporation and high steam-flow velocities of recent practice have increased the tendency to this action and accentuated its importance. Its magnitude is evidenced by the fact that a plant manager reports that devices inserted in his seven boilers to intercept such material prevented the carrying over of some sixty-eight tons of it in a single year, sixteen hundred pounds per boiler, per month.

Apathy in Coal Matters

APRIL first is approaching, carrying with it the possibility of a coal strike, incident to the breaking up of the Miami conference. Yet few, outside of the miners and certain operators, appear much concerned. This apathy on the part of the public may be attributed to the large stocks of bituminous coal on hand and to knowledge that the supply from non-union fields will be sufficient to keep industry going.

Such cessations of mining operations as do occur will likely be regional, and there are indications that in some sections agreements may be made between operators and miners to continue on the present basis.

There were many who severely criticized the Jacksonville agreement of three years ago, but in retrospect it is now widely conceded that this undoubtedly averted a suspension in coal production at a time when industry was ill prepared. Since then, the position of the union has been materially weakened by the growing output from the non-union fields, and it is no longer in a position to assume the aggressive rôle, but is fighting for its existence.

With sensibilities hardened by periodic disturbances in coal supply for the last eight years and an assured supply in sight, the public apparently cares little whether or not April first signalizes a strike.

Engineering Management

MANUFACTURING of many products involves a series of inter-related processes, each of which may be carried on in a separate department in charge of a departmental head. Unless there is some medium through which the needs of each department and the process as a whole are studied, there will be many opportunities for waste. Naturally, each department head is interested in making the best showing that he can. Therefore he cannot be expected to devote attention to finding out what other departments may be doing, unless it be functions that affect his particular problems. Engineering management has proved its economical value in co-ordinating the interests of all departments.

Power and heat applied in different forms are important factors in many processes. To supply these most economically calls for comprehensive knowledge of the requirements of each department. Then the power and heating system may be designed to best meet these requirements.

A good example of what engineering management may accomplish is given in this issue by Mr. Merrill, on page 439. Among the many things achieved by his organization, in one plant the coal consumption was cut one hundred and seventy-five tons per day, in three months, at a cost of less than five hundred dollars. With coal at six dollars a ton this is the equivalent to a saving of over three hundred thousand dollars a year, based

on three hundred days' operation. This is only one of the many improvements that have been made by putting the power and heating processes of these factories under engineering management. Frequently, the power and heating in manufacturing processes are lost sight of by those whose chief interests are in the financial end of the business. However, this particular instance, like many others, shows that in large plants there are as great, if not greater, possibilities for economies in power and heating as in any other department in the manufacturing process.

Steam-Turbine Nozzles

THE earliest steam-turbine nozzles were made with circular cross-sections at throat and mouth. These forms could be simply and accurately made with properly formed reamers and could be finished with smooth surfaces. The proportions were such that the steam would be expanded fully in the nozzle for one given set of pressure ratios. If, for instance, such a nozzle were designed for a given initial and outlet pressure, a change in inlet pressure generally resulted in either over or undue expansion in the nozzle with consequent decreases in efficiency. Such nozzles had as a consequence a limited range of use.

A circular nozzle of novel design has recently been developed in which the outer diameter is constant throughout its length. The throat and diverging section is formed by a central tapered pin. The position of this pin can be changed from outside the casing, and the nozzle can be thus adjusted for variations in pressure conditions. This design may have advantages in cases where changes in operating pressures are contemplated.

Nozzles of circular cross-section have elliptical mouths, which are less efficient in delivering steam to blading than rectangular mouths. Hence, circular nozzles are used now only for the first expansions of certain combination turbines or for small single-stage units.

Some of the earlier multi-stage impulse turbines used nozzles with circular throats and rectangular mouths. The change in section was secured by careful filing. The excessive labor involved made this form too expensive. It was superseded by rectangular nozzles formed by curved steel plates cast in place in the diaphragms. Little attention was given to the finish of the earlier passages. One turbine manufacturer built the nozzle partitions out of brass drawn to the proper form to provide the desired contour of passage, and these were held in place in the diaphragm by various devices. This increased the efficiency of the nozzle and the over-all efficiency of this particular turbine. Later on, a careful study was made of the forms of cast-in steel partitions and their efficiency was also improved. Some of these studies were carried out by means of a wind tunnel similar to those used in airplane investigations.

European builders of turbines for high pressures have found that it is necessary to design all nozzles very carefully, and some builders machine these throughout. This provides smooth passages designed for steam flow with a minimum of loss from eddies or turbulence. Such improvements, together with other developments, have so increased the efficiency of the high-pressure sections of turbines that this often exceeds that of the low-pressure stages. These changes suggest the thought that still higher efficiencies may be expected in large steam turbines.

Thinking in Advance of the Emergency

MAINTAINING high morale in an operating force requires considerable enthusiasm and executive ability on the part of those responsible. Although in a hydro-electric plant there are generally fewer men involved, the nature of the work or, rather, lack of work makes keeping up interest more difficult than in a steam plant. Where a plant may run along for months without anything very exciting happening, with plenty of time to put the machines on the line and take them off again, there is always the danger of the operators not being at their best should an emergency arise. The problem then becomes one of knowing what the attendants will do in case of trouble, when quick thinking and acting are necessary.

In the article on starting high-head hydro-electric units, there are a number of interesting suggestions for meeting emergency conditions. When a unit is to go on the system, the various operations are performed in the least possible time consistent with good service. In this way the operators become skilled in handling the equipment quickly and efficiently. The practice adopted in city fire departments in attending fire calls has elements that recommend it to the attention of operators—every call is treated as an emergency.

When taking a machine off the system, the practice of synchronizing the generator from the switchboard after the oil switch is opened, and then shutting it down by the hydraulic operator running the load-limiting device to the closed position, leaves the unit so that it will come nearly into synchronism, when it is again started, without adjustment by the switchboard operator. The operators also know the speed to which the machine will accelerate when started and are in a position to get it on the system with the least amount of false effort. It is difficult to foresee every emergency that may arise, but much can be done to meet these emergencies by training the operators to think and act quickly and do as much of their thinking beforehand as is possible.

Misleading Simplicity

IT IS really too bad that the thermometer is such a simple instrument. Just a bit of mercury in a glass tube, with marks to show how much room the mercury occupies. Nothing could be simpler. One just dips it into something and, presto, the temperature is indicated. The difficulty is that the indication of the thermometer is often not at all the temperature of the material in contact with its bulb.

Of course, if one is content to know the temperature of something within four or five degrees, the thermometer will serve nicely, but if one insists on knowing the nearest degree, or the nearest tenth of a degree, the task is not so easy. And it is not hard to find cases in the actual plant where errors of ten or a hundred degrees are likely.

If the thermometer had an array of screws and levers, one to be adjusted to compensate for each error to which the instrument is subject, we should all have greater respect for the difficulty of measuring temperature.

If an accurate knowledge of temperature is an important part of his job, the engineer should dig into the subject a bit and try determining a few corrections for his own conditions. They may prove to be surprisingly large.

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted.

Inspection and Care of Traveling Cranes

How often are the traveling cranes and lifting hoists in power plants examined or inspected by a competent man?

Engineers frequently go about a repair job and remove the casing from a turbine, lift out the rotor or remove the armature or field, any one of which may weigh several tons, and yet never give a thought about whether the hoist is in a safe condition to carry such valuable machinery.

Happily enough, traveling cranes seldom get out of order, but an inspection of the keys, setscrews, pins, etc., once a year may save a valuable piece of machinery or even one's own life and that of others.

The tracks should be kept free of dust and dirt by scraping. If allowed to accumulate the dirt will cake under the pressure of the carriage wheels and cause the crane to run unevenly. I have seen the safety latch rusted and sticking so badly that it would not drop down and engage the ratchet wheel.

The fact that traveling cranes are generally placed from 40 to 60 ft. from the floor level and then only accessible by means of a long ladder, may be one reason why they are so often neglected.

However, it is generally possible to reach them, and a good examination and a few drops of oil or grease where needed may many times repay the effort.

New Bedford, Mass. R. G. SPOONER.

Keeping Turbine-Generator Slip Rings in Condition

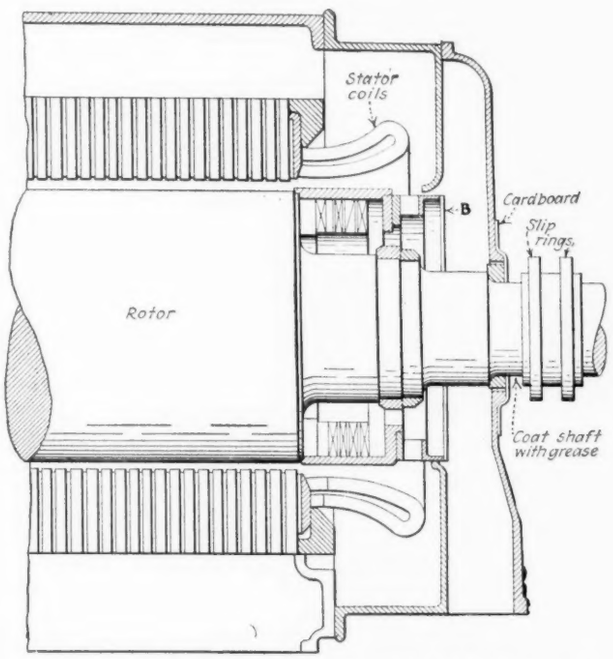
There have appeared many times in *Power* discussions on how to prevent power-plant troubles, and I would like to give your readers the benefit of my experience with turbine-generator slip rings. These rings are usually made of chilled cast iron, and owing to high speed, poor conductivity, vibration, oil, dirt and other causes, they develop flat spots and have to be trued up. On some makes these rings are in two parts and on others in one piece. Usually, the positive ring is the first to give trouble, but if the leads are interchanged about once a month, the wear remains fairly even on both rings and the necessity of truing is reduced.

To make the machine compact and to keep from carrying the field leads through the shaft, most manufacturers locate the field-coil slip rings inside the outboard-generator bearing and so close to the end bell that it may be difficult to adjust the brushes when the machine is running. Quite often the ventilating system causes a suction that draws oil vapor from the end bearing past the oil deflectors and onto the slip rings, which causes pitting and sparking on these rings.

In order to true up the rings properly, it is necessary either to turn them with a tool or grind them when the machine is running slowly. This work often throws iron and other dust into the end bell, so that the fine particles work themselves into the winding insulation and may cause a ground that is difficult to clear.

Being a strong magnet when energized, the field structure has considerable residual magnetism when not energized, and it is well to coat the shaft with heavy oil or grease before starting to turn the rings. Then cut from heavy cardboard a large circle that makes a close fit on the shaft and fasten this to the outboard side of the end bell by glue or shellac, as shown in the accompanying sketch.

In the case of machines where the rings are close to the end bell, the bell can be removed and a sheet-metal disk attached to the ventilating fan, as at *B* in the figure. These simple protections will be of great assistance in keeping the dust out of the machine when truing up the rings. The rings are trued with a grinding wheel or with a lathe tool. During the truing process the machine is turned slowly, and a diamond-point lathe tool may be used to obtain satisfactory results. After a turning job with a lathe tool is done, sandpaper the rings smooth, then remove the grease and cardboard. Do not use compressed air to do the cleaning, but carefully wipe all parts with clean rags. As a final check it is a good plan to make an insulation-resistance test between the two rings and also between each ring and ground.



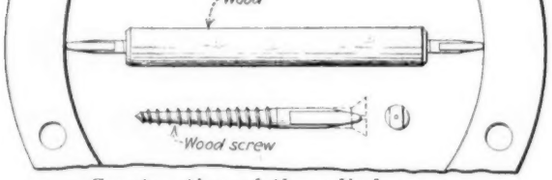
Section through part of steam-turbine driven generator

CARL WILDEY.

Chicago, Ill.

Adjustable Gage for Cylinder Bores

The gage shown in the illustration was made to check the bore of steam-engine cylinders. It is superior in many ways to inside calipers and is much easier to handle. The amount a cylinder is out of round or the amount of taper can be easily determined with a piece of paper of a known thickness or with a feeler gage. In case of measuring engines for reboring, it will be found much more satisfactory than calipers for sizing the pistons, which may be made in a shop



Construction of the cylinder gage

some distance away from the job. There is not so much risk of disturbing the setting of the gage by accidents or careless handling.

It is made from a round stick about two inches shorter than the bore and two wood screws, which are pointed in a lathe as shown. Two flats are filed on the sides so that the points can be adjusted with a small wrench or pliers. Before the screws are inserted in the stick, the latter should be drilled with a drill a little smaller in diameter than the wood screw, to prevent splitting the wood. H. L. WHEELER.

Syracuse, N. Y.

Why the Turbine Overspeeded at Light Load and Failed to Carry Full Load

In the power plant where I was once employed, the main turbine-generator unit, a 3,000-kw. 2,300-volt 1,800-r.p.m. machine did not govern properly. At light loads the machine would run fast, and when the load reached 2,500 kw. no more could be carried, as the machine slowed down. Adjusting the governor did not remedy the condition. All the valves appeared open and the vacuum was high, but no more load would it carry.

Testing the switchboard instruments showed they were O.K. The condenser was opened up and thoroughly cleaned; in fact, we did this nearly every week. The governor was taken apart several times, but appeared to be in good condition. At last the chief suggested that we take the unit off the line and give it a general overhauling.

While other men were going over other parts of the machine, I undertook the job of grinding the nozzle valves. There were nine valves in all and it was a hot job grinding them. By the time I reached the seventh valve I was getting somewhat discouraged as all the previous valves had needed but little grinding. Anyway, I removed the bolts and took out the spring and stem, but there was no seat on the stem. Looking into the body of the valve I found the seat cocked over on one edge. There was the cause of our trouble. At light loads the governor mechanism could not shut this valve and at heavy loads it could not open it.

Needless to say, the unit operated at its former efficiency after we put everything together, with a new stem and disk in place of the broken one.

Rosedale, L. I. JOSEPH O'BRIEN.

Records for Metallic Packing and Cylinder Lubrication

At the plant of the Rockwell Manufacturing Co., Milwaukee, Wis., there was installed under my supervision a 20x30-in. poppet-valve generating unit of 212 kva. capacity running at 150 r.p.m. This unit operates under the following conditions: Steam pressure, 150 lb. gage; superheat, 120 deg. F.; back pressure, 3 lb. gage. The running time actual per year is 2,800 hours. The piston travels 800 lin.ft. per min., or 38,000 ft. per hour.

In eleven years this piston and tail rod, 5¼ in. diameter, has traveled 1,478,400,000 ft., or 280,000 miles. The original metallic packing is in service and seems good for many years' future use.

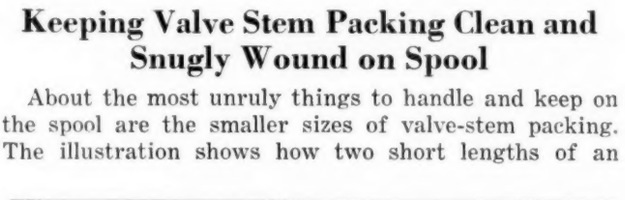
Incidentally, in 1916 this engine with a full floating piston was lubricated with 27.5 gal. of cylinder oil costing 55c. a gallon. The cylinder surface swept over by piston rings was 11,052 acres for one cent's worth of cylinder oil.

In 1916 the actual running time was 2,898 hours and the piston rings swept over 16,717.39 acres, or 26.12 square miles. This is what I call a fair performance.

Milwaukee, Wis. CHARLES A. CAHILL,
Consulting Engineer.

Keeping Valve Stem Packing Clean and Snugly Wound on Spool

About the most unruly things to handle and keep on the spool are the smaller sizes of valve-stem packing. The illustration shows how two short lengths of an



Pieces of inner tire tube keep packing clean and tightly wound on spool

old inner tire tube make this packing easy to handle.

Several inches of the tube are forced over each end of the spool, leaving an opening in the center, through which the packing is unwound as used. The rest of it is always pressed in place tight on the spool. When the packing is about used up, the rubber still forms a casing which keeps it from getting away. Odd bits and short lengths are easily kept on the spool by snapping a portion of the rubber over them. The packing, moreover, is kept moist and clean. FRANK W. BENTLEY, JR.

Missouri Valley, Iowa.

Faulty Operation Causes Explosion and Damage to Boiler Setting

When an accident occurs in a power plant from some unknown cause and an investigation is ordered, the investigator usually visits the scene, examines the results, questions all who were present or may have knowledge of the accident, combines this information with his past experience and forms an opinion which, in many cases is far from correct, owing to the distribution of evidence or the desire on the part of the operators to conceal a blunder.

Some time ago, an explosion occurred in the setting of a 250-sq.ft. inclined-tube boiler, destroying practically all the baffles and requiring the resetting of all brickwork from the bottom line of the drums upward. Apparently, the explosion centered in the space between the center and rear drums. This space is bricked off from the rest of the setting in this type of boiler, by tile carried on the circulating tubes connecting the upper drums.

All the floor tile were found down among the main tube banks, the ends of the chamber were pushed out and the roof badly broken up. This condition also existed in the space between the first and second drums, but to a less serious extent. The main side walls, while showing cracks, were not seriously damaged, but the rear wall at the top of the last pass was pushed out approximately four inches. The boiler was equipped with 126 bunsen burners of an approved type and was burning a straight natural gas.

The fireman on duty at the time told a straightforward story—told it many times without variation—and all additional information available tended to corroborate his statements. He stated that the boiler had been shut down for several hours, that the steam pressure was approximately 50 lb., that he lit the burners in the usual manner, that after a period of twenty minutes or a half an hour the steam pressure stood at 70 or 80 lb., that suddenly the fires, which normally make a decided roaring sound, went quiet, that before he could close the fuel valve, the explosion occurred with the results mentioned.

At the request of the owner the company from which the boiler was purchased, the insurance company, a State Commission, and the gas company each sent an investigator. One reported that some malicious individual had probably closed the gas valve at the meter house (located at some distance from the plant) and then reopened it. This in spite of the fact that the gas company's recording chart showed plainly that no interruption in the gas pressure at the meter had occurred. Another believed that part of the burners had failed to ignite, resulting in a pocket of gas forming in the upper setting, and this being finally ignited caused the explosion. To anyone familiar with the type of burner and the baffle system used to insure combustion, this version does not appear possible. The other two, together with those in charge of the plant believed that a slug of water, oil or air had come through the gas line in such quantity as to interrupt the gas supply temporarily, but an examination of drip legs in the gas line showed no recent sign of any oil or moisture coming over with the gas.

The air theory was accepted by the majority as the most plausible. The supposition was that a new line from which the air had not been removed was cut in on the main gas system and this air passing in a slug to the burners interrupted the gas for a short period, then, when the gas again entered the furnace, considerable volume accumulated before it ignited from contact with the hot brickwork. Because of the fact that the center of a stream of gas or liquid flowing in a pipe moves faster than the sides, owing to friction, etc., it seemed hardly possible that a slug of air could travel any considerable distance without becoming so diluted as to become at least an explosive mixture, which would not have extinguished the fires. Although accepting the air theory at first, the plant engineer continued to investigate, with the result that he has established a theory that differs entirely from all others, nevertheless is apparently correct.

The facts that the boiler had been shut down for not over four hours and that the steam pressure had dropped from 100 to 50 lb. aroused his suspicion. The fireman who shut the boiler down finally admitted that, after shutting down, the pressure ran up and the boiler was about to pop off, so, having had limited boiler experience, he opened the stack damper so the setting could cool off and thus prevent the safety valve popping. Needless to say, the remedy was effective, with the result that when the next shift came on duty to start up, the setting was cold. The boiler was being served by a small temporary stack, and the connecting breeching made a drop of approximately 3 ft. before entering the stack.

The second fireman, finding the steam low, was naturally in a hurry to get it up, so, thoughtlessly, he put all the fire possible under the boiler. There is no doubt that all the burners were ignited or that the damper was wide open, but if the setting had been equipped with a draft gage, it would have been found that little draft remained owing to the cooling of the setting and stack, so that upon starting a heavy fire an actual pressure was established in the setting. This pressure restricted the air supply to the burners, with the result that a considerable amount of CO was formed; the setting was new and tight, consequently this gas, rich in CO, worked up into the chambers between the drums, which are not vented. After a time the heat of the fire established a normal draft and the setting warmed up; then, as the pressure in the setting dropped, the mixture of CO and air in the chambers started to leak back and were ignited. Both men were at fault, as any fireman should know better than to cool down a setting or warm a cold one up as was done in this case. The absence of a draft gage and the temporary breeching and stack were also contributing agencies.

The boiler has since been connected to a permanent stack through proper breeching, is equipped with a draft gage, and the fireman instructed in its use. Also, several pilot burners have been installed which are supplied with gas through a system of piping, tank, and check valve connected at some distance from the plant. The capacity of this system is such that, should the gas supply be shut off, the check valve will close and the pilot burners continue to burn for some time after the main burners have been extinguished, and in case the gas pressure returns, they would be ignited by the pilots. This would also be true in the case of an interruption due to a slug, water or air or in fact of any foreign gas or liquid entering the system, as the time element between the main burner's supply and the pilot's varies considerably.

A. C. McHUGH.

Norwalk, Calif.

Comments from Readers

When the Engineer Welcomes the Salesman

Perhaps it was because of a grumpy mood that the engineer of one large power plant recently chased out a salesman. A comparative stranger, from a new house, yet what that salesman may not have represented! Some engineers welcome each salesman, and they make him feel welcome, which promises good for both individuals and also their employers. On the other hand, when ruthless repulses come between, there is loss, greater than may be imagined.

The foresighted engineer naturally does not consider the meeting of salesmen merely a personal matter, and he will not let personal views sway him materially. Whether he likes a certain salesman or not, whether the engineer is in agreeable mood, should not govern the receptivity. Just what has that salesman today, not only in products, but in ideas? Hasn't he perhaps a new kink, recently unearthed in another plant, that may just solve one of the engineer's perplexing problems? Incidentally, how many engineers do consult the traveling representatives relative to probable suggestions? Here, indeed, is a question well worth pondering.

Keen, shrewd salesmen are always observing; they are eager to do a good turn for those power plants where they are received courteously. Contrarily, however, they are not likely to be free with ideas for the benefit of plants where they meet nothing but rebuffs and where they are generally unwelcome. "Salesmen received only on Tuesday and Thursday mornings, 9:30 to 12:30." How often do we notice such an announcement? Does it not chill the ambitious salesman, and does it not restrain him a little? Does it not serve, moreover, to chain his good will and good ideas more closely to other power plants, to the loss of the one sponsoring the sign? It is well to bear in mind, too, that salesmen themselves exchange experiences; in a short time there gains the rounds the information that a certain power plant—or perhaps it is a certain engineer—is unfriendly to salesmen.

How many times has a salesman been instrumental in mastering an engineer's problems? Knotty ones, seemingly unsolvable, come up. Yet they are only seemingly so. The engineer may be a novice, or perhaps the difficulty is of a new kind, with which he has had little or no experience. Yet there comes the salesman who has witnessed just such troubles; he knows just what was done in other power plants. He transmits his information to the seeking engineer; in a short time all is well. Another good turn the salesman has done; the engineer is convinced of the value of salesmen aside from their prime province, and ever after he is determined to welcome them with open arms.

The power-plant engineer cannot get around so widely as can the salesman; and consequently he cannot observe the many interesting experiences of different and profitable kinds. He knows his own plant, but how things are done in other power plants, by different individuals—that is knowledge that belongs more to the traveling salesmen. And these men can, and gladly will, pass on their information for the benefit of the power plant and the engineer.

Has the salesman a good personality? Has he good products? Has he additional services afforded by the selling house? Does the engineer himself take with particular kindness to the salesman? All relevant questions, but one that the far-seeing engineer will never overlook is, Cannot the salesman, because of his peculiar position and fitness, furnish me with new, valuable information, that will enable me to be a better engineer, help solve my problems more easily, and generally get greater efficiency from the plant and the staff?

Let the engineer ponder, then decide on more positive action, where that is in order. The course cannot other than show the way to gain.

Brooklyn, N. Y. FRANK V. FAULHABER.

Power From Tropical Seas

Usually, the announcement of a new idea creates a very peculiar situation. In the aftermath the public grows unduly enthusiastic while the specialists begin the onslaught, criticizing it from the viewpoint of the current, and often quite unsuitable, standards of practice. The history of engineering is abounding in such facts.

R. H. Andrews (*Power*, March 1, 1927) wrote an article severely criticizing the suggestion of Georges Claude and Paul Boucherot on the realization of power from tropical seas. Of course their idea is by no means new. (See V.D.I. Nachrichten No. 11, 1926.)

Although R. H. Andrews gives some disappointing figures, the original method of working, as proposed by the inventors, can be so modified as to improve greatly the chances of commercial success. The initial situation, namely, 80-85 deg. F. surface temperature of sea water and 38-40 deg. at a depth of approximately 3,000 ft. with a temperature difference of 40 deg., precludes at large the use of *water vapor* as a working fluid, owing to its enormous specific volume (600 to about 2,000 cu.ft. per lb.) within this temperature range.

Let us consider the use of another fluid. Take for instance sulphur dioxide. At 40 deg. its vapor pressure is 27 lb. abs. and at 80 deg. it is 60 lb. abs. The specific volumes are 3.0 and 1.35 cu.ft. per lb. respectively. Thus an engine, having sulphur dioxide as a working fluid, in this thermal range will be comparable in dimensions with the medium-pressure part of a common steam turbine.

Furthermore, the adoption of a fluid more suitable than water simplifies the question of pumping sea water and eliminates the trouble of extracting great amounts of air—the last so well stressed by R. H. Andrews. For instance, a large open pool may be excavated in the shore and hot surface water circulated through it by a

low-head pump. A large heating surface of pipes placed in the pool will be inexpensive. These will serve as boilers. A covered or underground pool with a battery of pipes will be the condenser. The pumping of cooling water from a depth of 3,000 ft. will be to the sea level, not to 50 ft. above, as was considered by R. H. Andrews.

Thus, the pumping of cooling water will be only against the friction head in large pipes or, in other words, against not more than 20 to 25 ft. head, which is usual in condenser installations.

It may be noted by the way that such an arrangement may be easily extended on land to utilize the daytime solar heat, making thus an harmonious whole. In early attempts solar energy could not be utilized properly when taken alone without a cold source, but in conjunction with cold sea water the combined system of using a common generating unit for the two sources of energy may prove to be economical and will increase greatly the capacity. N. ARTSAY.

New York City.

Circulation of Water in Steam Boilers

From the number of papers read at meetings of engineering associations in the past, one might conclude the last word had been said on the subject of water circulation in steam boilers.

On examining the patent specifications of early water-tube boilers, the circulation is supposed to be perfect. Later specifications claim increased or improved circulation. One might wonder how perfection can be improved.

Prof. John Perry, late of the Royal College of Science, London, England, in his book "Gas, Steam and Oil Engines," Chapter 11, refers to this matter, stating that there is a film of water which adheres to the heating surface of a boiler which, if removed, would increase the transmission of heat many times. He suggests the use of a motor inside the boiler to give sufficient motion to the water to keep this film brushed away. Professor Austin says the thickness of the film is 0.004 in. A device is now in use in Great Britain which proves the statements of Perry to be true. In a rough working test measuring fuel and water only, 15 per cent increase in evaporation is obtained.

The word circulation is used loosely. When used in connection with boilers, it might be understood to mean a movement close to the plate, to cause a rubbing effect, to distinguish it from a mere movement of the body of water. Engineers admit that good circulation is important, but few admit that fuel can be saved by increased circulation.

In Lancashire and Scotch marine type boilers circulation, as the term is generally meant, eliminates unequal expansion with consequent leaky seams and grooving at the furnace ring flanges.

It is common to hear of replacements by larger boilers having a better circulation. On consideration natural circulation cannot be more than the amount of feed water, while larger boilers for the same evaporation will have less or a slower circulation per unit of area of heating surface.

In a water-tube boiler where the circulation is supposed to be close to perfection, the evaporation per pound of fuel is about equal to any other type of boiler, not including those of special construction or fittings for the purpose of utilizing the heat of waste gases. This shows that the film of water is present in such boilers.

It will be understood that with a fire on one side of a furnace plate, and water on the opposite side, steam patches or bubbles will be formed on the surface of the plate, which will cover a large part of the surface, keeping water away. Steam is a bad conductor of heat compared with water, and its presence reduces the available heating surface. By the use of the device already mentioned, the steam is washed away and allows water to be in contact with the whole surface at all times, which increases the effective heating surface and consequently the evaporation per pound of fuel.

In a water-tube boiler the steam is generated on the inside surface of the tube all the way round, and is formed so quickly as to keep the body of water away from the surface and to force the central core out of the tube, giving the appearance of exceptionally rapid circulation.

While heating feed water by waste gases, exhaust steam or internal live steam heaters increases the evaporation, it has the effect of increasing the steam bubbles. This is proved by the fact that with forced circulation better results are obtained than when the feed water is not so treated. ISAAC TODD.

Oak Park, Ill.

Turbines Were Too Efficient

I was much interested in the series of articles by S. T. Powell on the treatment of feed water and was pleased to learn that this valuable matter is soon to issue from the press in book form.

A forceful demonstration of the importance of feed-water knowledge recently took place in a new plant located less than one hundred miles from New York City. This plant was built by one of the best engineering firms in the country with a most enviable reputation. No expense or engineering talent was spared in order that that reputation might be added to, and I think it was and still think so.

The plant is a waste-heat-boiler cement plant using the wet system or slury-tank method of feeding the gravy-like mixture of ground limestone and other ingredients into the kilns, over which were located the boilers.

The power plant consists of two 2,500-kw. turbines, one of which was to be spare. Everything is motor driven, and the employees' model houses are furnished with an abundance of current for lighting and cooking purposes.

The turbines are on surface condensers. No steam is wasted; all water is returned to the boilers. There was some slight apprehension as to pitting due to excessive purity, but it was remarked that it would take but precious little of the raw water available to cure that trouble.

The plant started up with everything going as calculated, except that production was in excess of the figures and everybody wore a broad grin and lit long black cigars. The wet process eliminated all dust, the slight haze seen when approaching the plant being produced by the aforementioned long black cigars. Then it was noticed that as the men in charge of the kilns increased production in a way to delight the management, the safety valves were caused to sing a merry tune rather frequently.

The makeup water proportions increased until it was thought advisable to put on the other turbine, which

was done with very little result, as water consumption rarely went above 16 lb. per kw.-hr. This was far from sufficient to use up the water evaporated by the boilers and return it to them again via the condenser.

These conditions continued for about six months, when unmistakable signs of distress due to scale in the boilers was noticed and the entire plant had to be shut down for turbining the tubes. The plant is now running with a 1½-in. pipe from the condenser inlet open to the atmosphere through a valve adjusted by hand to kill the vacuum to eight inches in order to increase steam consumption of the turbines to use all the steam that the boiler could make.

It would seem that preliminary pyrometer and flow records taken at other waste-heat boiler plants with kilns of the same size fired under similar conditions would have shown it unnecessary to purchase power-plant units with a steam rate as low as 13 lb. and blow the surplus to waste through the safety valves, especially in a country with a makeup water of that character.

This plant is, however, a winner with all its raw-water troubles, for it is producing cement of a super high grade at an exceptionally low cost, and I am sure that all except the mistake of purchasing highly efficient high-cost prime-mover units will be overcome notwithstanding there is no market for the surplus current at present.

E. E. CLOCK.

Passaic, N. J.

Watch the Holes in Flame Plates and Injection Nozzles

To obtain the best results with an oil engine, the engineer must watch the combustion, for when combustion is not right the engine does not work right. Poor combustion is bound to hurt cylinder lubrication, which in turn augments ring and liner wear. If the products of poor combustion leak past the pistons and into the crank-pits, thus fouling the oil that goes to the bearings, trouble is likely to develop with the lower working parts as well. In fact, the far-reaching tendency of fuel oil that is not completely burned to cause trouble is so well known that it should not be necessary to tell the whole tale, more especially since it has already been told many times.

In considering the matter of combustion control, we should bear in mind that before the fuel is burned it receives its final preparatory treatment when it is forced through the flame plates or spray nozzles, and that no matter how perfect the rest of the mechanism employed in the delivery of fuel to the cylinders may be, if there is anything wrong at the very last end of the chain of devices, there is bound to be something wrong with combustion.

For this reason it is common practice to remove a fuel valve or spray nozzle and examine it carefully at the first indication of trouble. In all of these there is an atomizing device, while some have a needle and others have a check valve. Obviously, if dirt is found or the valves leak, careful cleaning or grinding will be required, while the method of so doing will need no description, assuming that the job is in the hands of a capable engineer.

Flame plates (sometimes termed burner plates) and spray nozzles are more sensitive to misuse than any other part of the device, and they are often damaged as the result of not being handled correctly. Some have very fine holes through which the fuel is driven under terrific pressure, while others have larger holes through which the fuel is blasted with air. But despite the pressure and high velocity of the elements passing through them, these holes will become stopped up sometimes, and they must be cleaned out before they will again function as they should.

To make these holes originally, a drill is employed that revolves at a rate of several thousand revolutions per minute, and a skilled mechanic does the work. It is not the task of an operating engineer, and for this reason it is impossible to use the same method to re-open the holes that is employed to drill them. However, a drill of the size of the holes and a small chuck to hold it may be obtained from the engine builder if not always from a hardware dealer. The trouble is that the drills are small and easily broken or lost, and they appear so insignificant that the engineer often finds himself without them before he is aware of it. He then employs any fine instrument that he thinks will be suitable. He pokes about with a piece of fine wire or needle until he breaks one or both off in the hole and then in desperation searches for something else. He scratches, scrapes, blows with compressed air and washes with kerosene. As a result the holes are not being completely opened or their surface and edges are slightly damaged.

One of these holes that is partly clogged will start to close itself farther, in most instances, as soon as it is put back in service, and one that is damaged will do the same thing. In the first instance the substance with which the hole is partly clogged forms a base upon which more foreign matter will accumulate, while in the second case the roughened surface tends to gather accumulations also.

There is another peculiar characteristic of these holes, which is best illustrated with a water hose nozzle. If it is battered at the small end, it will throw a distorted stream. If it has a fine taper and rounded edges, it will throw a clear unbroken stream. If it has a sharp or ragged edge, the water will drag and eddy and it will throw a broken and irregular stream. The slightest irregularity of the inner surface at the end of the nozzle will have a marked effect upon the manner and shape in which the stream breaks from the nozzle.

Similar effects are obtained when the holes in a flame plate are damaged. In the oil engine we do not want distorted blasts of atomized fuel. What we want is as near a uniform atomization and distribution of fuel as it is possible to obtain, and this we cannot have unless we use exceptional care to keep the holes in the flame plates or injection nozzles as near their original shape and dimension as it is possible to maintain.

Not fully understanding the importance of painstaking care and the employment of a method that may be depended upon to restore the holes to their original shape and size, the operator may encounter difficulties which he will lay to faulty design, when as a matter of fact he is unintentionally responsible. In this case the *method* must be correct since the holes are often too small to examine inside with the naked eye. Using a drill of the right size is of course the only correct method of doing the work. The result of renewing the flame plates is quite satisfactory so far as the operation of the engine is concerned, eliminates the need of being so careful with the holes, and is resorted to by some, but it is expensive.

A. B. NEWELL.

Woodbury, N. J.

New and Improved Equipment

Herman Nelson Model 20 Unit Heater

An improved unit heater of the extended surface type, in which the core or steam way is cast in one piece of a special alloy, has been brought out recently by the Herman Nelson Corp., Moline, Iowa. The employment of a cast core *A*, Fig. 1, obviates the use of soldered, brazed or welded joints. Intimate metal-to-metal contact of the extended surface *B* is attained by wedging spring-flanged fins onto the core and keying them in position. Steam from the line *C* is distributed to the sections of the unit by a manifold, and the condensation is drained from the

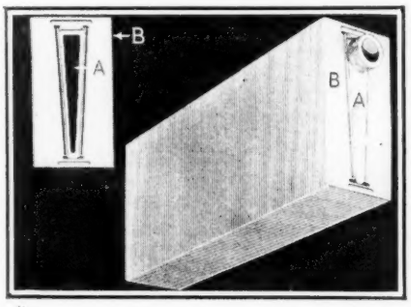


Fig. 1—Cast steam core with fins

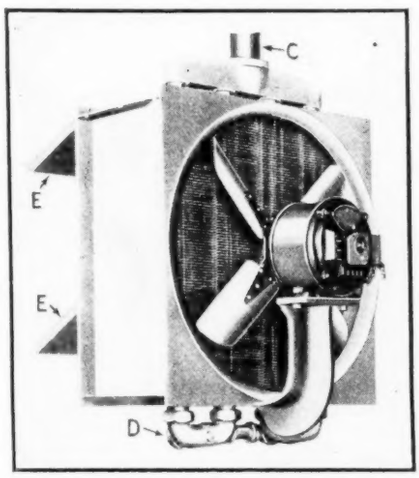


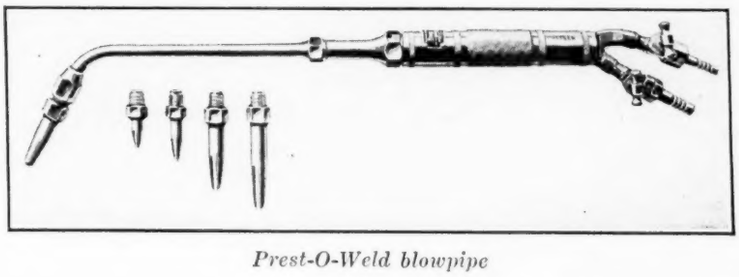
Fig. 2—View of heater, showing steam and condensation manifolds and deflectors

lower manifold *D*. Deflectors E serve to direct the heated air stream as desired.

The heater complete, with motor and deflector, weighs approximately 170 lb. and occupies 4 cu.ft. of overhead space. Its light weight permits suspending it directly from the pipe line. At 1,150 r.p.m. it will deliver in excess of 2,000 cu.ft. per min. The heater is designed to operate on any steam pressure from atmosphere to 125 lb.

Prest-O-Weld W-101 Blowpipe

A type of welding blowpipe W-101 for wide range service, in which the oxygen and acetylene enter the inlets at about equal pressure and are thoroughly mixed in a simple mixing chamber, has been recently introduced into the welding field by the Oxweld Acetylene Co., 30 East 42nd St., New York City. It is claimed by the manufacturer that the intimate mixing that takes place under all working conditions eliminates waste of gases and the time of the operator in maintaining the neutral or working flame.



Prest-O-Weld blowpipe

The blowpipe is of all brass construction and is screwed together on metal-to-metal seats with no packed or soldered joints. Stems for the blowpipe are made in three lengths—4, 9 and 19 in.—each of which is made in three angles—45, 60 and 90 deg.

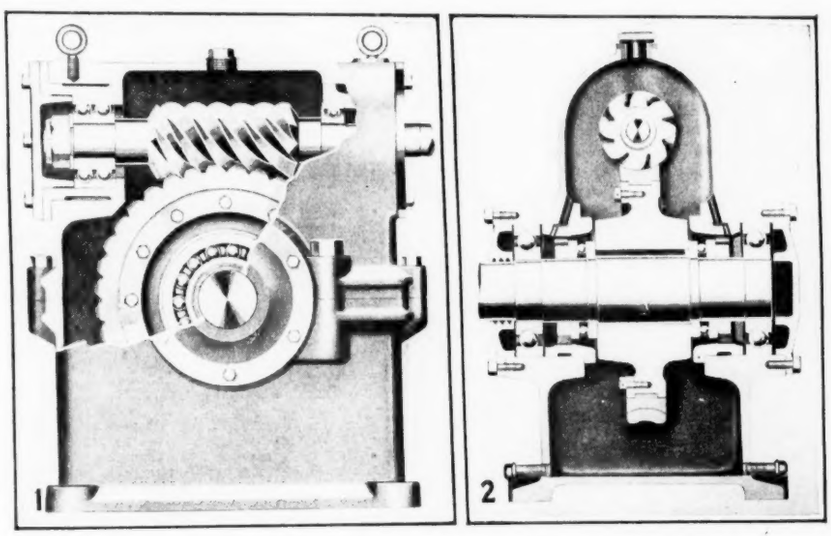
Ten interchangeable tips are offered, five of these together with two stems being furnished as standard equipment.

Improved Foote Reduction Gears

An improved line of worm-gear speed reducers has been placed on the market by the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill. The units are made in sizes ranging from fractional horsepower up to 200 hp. and in ratios of reduction ranging from 4 to 1 up to 100 to 1 for the single-unit type and up to as high as 10,000 to 1 for the double-reduction type.

High-grade ball bearings are used to take care of both the radial and thrust loads on the worm and worm gear. In the case of the worm a double-row ball bearing is used, and on the worm-gear shaft independent bearings are used for thrust and radial loads, as will be clear from the illustration.

A special form of tooth design is employed. The wormwheels are made of chilled cast bronze, and the worms are made of nickel steel casehardened and ground. Four general types are provided: With the worm below the gear, above the gear, with the worm shaft in a vertical position and a combination of two units making a double reduction.



Cut away and sectional views of improved reduction gear

The Economic Advantages of the Combined Production of Power and Heating Steam

By V. RENIGER

THE author presents figures for four designs of a small industrial power plant.

THERE are many industries that, in addition to mechanical power, have need for considerable quantities of heating steam. The following examples indicate the range of quantities required, in pounds of steam per kilowatt-hour of power required for the manufacture of various products:

Beer	14 lb.
Paper	17 lb.
Cellulose (pulp)	40 lb.
Artificial silk	57 lb
Sugar	84 lb.
Alcohol	210 lb.

Combined installations have already been worked out, grouping certain industries having need for large quantities of heating steam and little power with others requiring much power and little heat.

The object of this article is to direct attention to the economic advantages of such combinations, and particularly to discuss the influence of extraction and back-pressure turbines on the thermal efficiency, and hence on the cost of producing a kilowatt-hour.

The Basis of the Study

The study will be based on a power plant of 2,000 kw. capacity at the terminals of the alternator, equipped with a steam turbine without extraction, exhausting to a surface condenser. The production cost per net kilowatt-hour produced may be divided into fuel, operation (labor, oil, and supplies), maintenance, changes and repairs, and amortization. These composite costs, per hour of operation, added together, will be divided by the net power (2,000 kw.) diminished by the power required by the auxiliary equipment of the plant (75 kw.).

It will next be assumed that this station is modified so that 50 per cent of the total steam entering the main turbine is extracted at a pressure of 57 lb. per sq.in. gage, for the purpose of heating. (This pressure of 57 lb. per sq.in. gage is common in industries using steam for heating.)

The output at the terminals of the alternator will always remain equal to 2,000 kw. From the total cost per hour of operation, calculated as already explained, will be deducted the portion chargeable to the production of heating steam, calculated separately for a plant to produce heating steam only, in order to obtain by difference the net cost per kilowatt-hour. Then similar calculations will be made for an extraction of 75 per cent of the total steam entering the main turbine, and finally for back-pressure operation with all the steam used for heating.

The operating and maintenance costs for these different cases have been established by comparison with the cost in the first case.

Of all the costs, that for coal is evaluated with the greatest precision. The others, and particularly amortization, are only approximate. The errors resulting from an inexact estimation of these costs, which vary with different installations and with the duration and rate of amortization, are of only secondary importance, for they represent only about 30 per cent of the total expense, even for the relatively short period of amortization assumed in this article.

The results of the studies are given in the form of tables with explanatory notes.

These figures lead to an appreciation of the advantages of the combinations whose variations have been studied, and may serve as a guide in the study of a power-plant project furnishing at once steam for prime movers and for heat.

Symbols and Assumptions

The following symbols are used in the tables to indicate various combinations:

O—The simple condensing plant without steam extraction.

50*X*—50 per cent of the steam passing the turbine throttle is extracted.

50*H*—A heating plant producing the same quantity of low-pressure steam as is extracted from the turbine in 50*X*.

75*X*—A plant with 75 per cent of the total steam extracted.

75*H*—A heating plant producing the same quantity of low-pressure steam as is extracted from the turbine in 75-*X*.

100*X*—The plant is equipped with a simple back-pressure turbine, all the steam passing the throttle being exhausted into the heating system.

100*H* — A heating plant producing the same quantity of low-pressure steam as is exhausted from the turbine in 100*X*.

Characteristics Common to All Installations

Boiler pressure	356 lb. per sq.in. gage
Boiler steam temperature	617 deg. F.
Turbine steam pressure at the throttle	327 lb. per sq.in. gage
Turbine steam temperature at the throttle	572 deg. F.
Turbine steam pressure at the extraction nozzle	56.9 lb. per sq.in.
Turbine exhaust pressure	1.28 lb. per sq.in. abs.
Temperature of circulating water at the condenser intake	81 deg. F.
Alternator: Continuous rating	2,000 kw.
Heat content of steam at turbine throttle	1,295.1 b.t.u. per lb.
Heat content after isentropic expansion to extraction pressure	1,148.4
Heat drop to extraction opening	146.7
Heat content after isentropic expansion to exhaust pressure	904.5
Heat drop to exhaust pressure	390.6

Heat quantities were taken from the entropy diagram of Stodola, and converted to English units, so that they may not agree with results from other tables or charts.

TABLE I—TOTAL STEAM FLOW

Plant *O*	7.2 lb. per sec.
50*X*	10.5
75*X*	13.6
100 *X*	18.7

The turbine bucket efficiency is taken as 85 per cent, the alternator efficiency 92 per cent, the reduction gear efficiency 97 per cent, and the power at the alternator terminals 2,000 kw.

TABLE II—HEAT BALANCE

Items 1 to 6 are in B.t.u. per sec.

	O	50*X*	50*H*	75*X*	75*H*	100*X*	100*H*
1. Heat content of steam leaving boiler	9,450	13,780	6,190	17,870	12,070	24,690	22,240
2. Heat lost between power house and heating plant	163	199	.....	226	.....	262	.....
3. Heat delivered to the heating plant	0	6,190	6,190	12,070	12,070	22,240	22,240
4. Heat exhausted to the condenser	7,100	5,200	.....	3,390	.....	0	.....
5. Heat returned to boiler by feed water	453	1,040	683	1,640	1,400	2,440	2,440
6. Heat to be delivered by fuel (Item 1 minus Item 5)	8,997	12,740	5,507	16,230	10,670	22,250	19,800
7. Coal requirements, lb. per hour	3,220	4,570	1,960	5,780	3,810	7,940	7,060
			+22		+31		+44
			1,980		3,840		7,100
8. Coal chargeable to power generation (difference between *X* and *H* plants)	3,220	2,590	.....	1,940	.....	840	.....
9. Thermal efficiency of power generation, based on heat chargeable, per cent	16.9	21.0	.....	27.8	.....	65.5	.....

1,900 B.t.u. per sec. is the net work developed at the alternator terminals.

It is assumed that the unrecoverable mechanical losses (bearings and pumps auxiliary to the turbine), reduction gear, and alternator losses, are 278 B.t.u. per sec.

It has been assumed that 70 per cent of the heating steam is returned as water at 203 deg. F., makeup being furnished by water at 68 deg. F. and by condensate from the main condensers at 100 deg. F.

For coal a heating value of 12,600 B.t.u. per lb. has been assumed, and a boiler efficiency of 80 per cent. For installations producing only heating steam, there has been added the fuel necessary for the production of power required for auxiliaries, assumed to be generated by back-pressure units.

*Translated from Le Génie Civil, Jan. 22, 1927, page 102.

The following discussion of costs has been converted into dollars on the assumption that 5 francs are equivalent to 1 dollar. The absolute values may not be significant, but the relative figures are believed to present a true picture of the author's contention.

TABLE III.—COST DATA

Converted to dollars assuming 5 francs equal to 1 dollar.

	O	50*X*	50*H*	100*X*	100*H*
Coal per hour	40.80	58.00	25.20	101.00	90.00
Operating expenses, per hour	3.30	3.30	1.92	3.30	1.92
Maintenance, per hour	3.34	4.00	1.80	6.00	4.80
Amortization:					
(a) per year	83,000	97,400	31,400	133,000	96,000
(b) per hour	17.30	20.30	6.54	27.80	20.00
Total cost of operation, per hour	64.74	85.60	35.46	138.10	116.72
Cost of producing power, per hour	64.74	50.14	.....	21.38	.....
Power absorbed by the auxiliaries, kw	75	83	25	100	70
Power available at the switchboard (2000-G), kw	1925	1917	.....	1900	.....
Cost per kw.-hr	0.0338	0.0262	.....	0.0112	.....
Ratio of fuel-cost to total cost, per cent	63	68	71	73.5	77

For extraction or back-pressure units the relative cost of producing power alone has been taken to be the difference between the total relative cost for the production of power and heating steam (as for case 50*X*) and the total relative cost for the production of steam alone in the corresponding heating plant (50*H*).

Estimate of Various Annual Costs

The annual operating expense has been based on 300 days per year, 16 hours per day, in two shifts. For installations producing power and heating steam, the staff has been assumed to comprise 2 engineer-electricians at $6,000 per year, 2 firemen at $4,800, and 2 helpers at $4,000 with $1,000 for oil and supplies, giving a total expense of $15,800 per year. For installations generating low-pressure heating steam only, the crew has been assumed to be made up of 2 firemen at $6,000 per year, and 2 helpers at $4,000, with $400 per year for oil and supplies, giving a total of $9,200 per year.

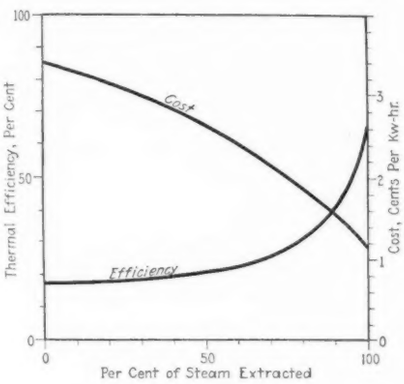


Fig. 1—Variation of net production cost per kilowatt-hour, and of thermal efficiency for various quantities of steam extraction

When the quantity of extracted steam increases from zero to 100 per cent of the total quantity of steam entering the turbine, the power remaining constant, the cost of operation per kilowatt-hour reduces to about one-third, and the thermal efficiency of the installation increases approximately 3.7-fold. The variation is slow up to about 75 per cent extraction, and then more rapid.

For installation *O* the maintenance cost has been assumed equal to the operating cost, as is frequent in small power plants. For the other installations they have been taken from the corresponding costs for plant *O*, assuming that the greater portion of this cost (about 75 per cent) originates in the boiler room.

It is assumed that the installation must be amortized in ten years at a rate of 7 per cent compound interest. One thus obtains the annual amortization charge by multiplying the cost of installation by 0.143.

APPROXIMATE COST OF INSTALLATIONS

Installation O

Boiler Plant—Output 25,800 lb. per hr. Pressure, 355 lb. per sq.in. Steam temperature 617 deg. F. Boilers with economizers and superheaters, mechanical stokers, feed pumps, feed tanks, forced-draft fans and stacks, settings and foundations, mechanical coal handling, and complete piping of boilers and auxiliaries $280,000
Engine Room—One 2,000-kw. turbine-alternator, with reduction gear, surface condenser for 25,800 lb. of steam per hr., auxiliary pumps, complete piping of main unit and auxiliaries, switchboard and all accessories $200,000
Building, complete with traveling crane $100,000
Total $580,000

Installation 50X

Boiler Plant—Output, 37,700 lb. per hr. Pressure, 355 lb. per sq.in. gage. Steam temperature, 617 deg. F. The plant is identical with plant *O* $380,000
Engine Room—Identical with that of plant *O*, except that the turbine is arranged for extraction, and that the condenser is calculated for 18,850 lb. of steam per hour $180,000
Building complete $120,000
Total $680,000

Installation 50H

Boiler Plant—Output, 18,850 lb. saturated steam at 114 lb. per sq.in. gage. The specification is identical with that for plant *O*, except that the superheaters have been omitted, and that the pressure is reduced $160,000
Building complete $60,000
Total $220,000

Installation 100X

Boiler room—Output, 67,300 lb. of steam per hour at 355 lb. per sq.in. gage, and 617 deg. F. The specification is identical with that of plant *O* $640,000
Engine room—One 2,000-kw. back-pressure, turbine-alternator with reduction gear, complete piping switchboard and all accessories. $140,000
Building complete $150,000
Total $930,000

Installation 100H

Boiler room—Output, 67,300 lb. of saturated steam per hour at 114 lb. per sq.in. gage, saturated steam. The specification is identical with that for plant *O*, except that the superheaters are omitted and that the pressure is reduced $560,000
Building complete $110,000
Total $670,000

Compensation for Injury Received in "Horseplay"

By Leo T. Parker

In view of the fact that there has been considerable controversy whether or not an employee is entitled to compensation for injuries received while indulging in moments of play, it is interesting to note that various higher courts have held in the affirmative.

For example, in the recent case Cassell vs. United States Fidelity & Guaranty Co. (283 S.W. 127) it was disclosed that an employee, engaged at his regular work, was injured by a "prank" of a co-worker.

The court held the employee entitled to compensation under the Workingmen's Compensation Act, and said:

"Considering every employee peculiarly exposed to such pranks from his coemployees as are inspired by nothing more than a well-nigh universal human craving for fun, and recognizing that such pranks, when careless though innocent, not infrequently occasion bodily harm, we are forced to consider these pranks as a hazard which the employee required to work with others must encounter in the performance of his duties, and hence such pranks constitute a risk reasonably inherent in or incident to the conduct of the employer's business."

The records of another case (Leonbruno vs. Champlain Mills 128 N.E. 711) disclosed that an employee, while engaged in the performance of his duties in the employer's factory, was struck by an apple which one of his fellow servants, a boy, was throwing in sport at another, and as a consequence lost the better part of the sight of one eye. He did not participate in the horseplay and had no knowledge of it until injured. The question was whether the accident was one "arising out of and in the course of employment."

In holding the injured employee entitled to a recovery, this court said:

"That it arose 'in the course of employment' is unquestioned. That it arose 'out of' employment, we now hold. The claimant's presence in a factory in association with other workmen involved exposure to the risk of injury from the careless acts of those about him. He was brought by the conditions of his work 'within the zone of special danger.' . . . Whatever men and boys will do, when gathered together in such surroundings, at all events if it is something reasonably to be expected, was one of the perils of his service. We think . . . that it was 'but natural to expect them to deport themselves as young men and boys, replete with the activities of life and health. For workmen of that age or even of the maturer years to indulge in a moment's diversion from work to joke with or play a prank upon a fellow workman is a matter of common knowledge to every one who employs labor.' The claimant was injured, not merely while he was in a factory, but because he was in a factory, in touch with associations and conditions inseparable from factory life. The risks of such associations and conditions were risks of the employment"

News in the Field of Power

Governor Smith Proposes Referendum Measure in New Authority Bill

Measure Provides $100,000 for Investigation—Report to Explain Obstacles to Plan, Economic Conditions—Alternative Calls for People's Vote on State Power Operation

THROWING into discard the power authority bill as prepared by Julius Henry Cohen and introduced in the Legislature in January, Minority Leaders Downing and Bloch introduced in the Senate and Assembly the night of March 14 Governor Smith's latest proposal or rather proposals in relation to water power in New York State. This bill sets up a New York State Water Power Authority and appropriates $100,000 with which it is to investigate and report a comprehensive plan to the Legislature on or before Jan. 15, 1928. The measure contains a new provision in section 5.

Referendum Is Alternative

If the commissioners cannot present a plan under the conditions outlined in Section 3, their report shall not only state this fact, but it shall give the reasons for its conclusion and the source of the underlying difficulties causing this. Whether, in the opinion of the commissioners, the obstacles in the way of the development of such a comprehensive plan are removable by state, federal or other action, or whether they arise from unalterable economic conditions, is also to be stated in the report.

As an alternative, the second bill provides that there shall be submitted to the people at the general election in 1927 the question, "Should a new law be passed providing for development of the water-power resources of the state on the Niagara, St. Lawrence and other streams by a state power authority similar to the Port of New York authority, instead of proceeding under existing law to grant to private corporations licenses to develop such resources?" The question would be submitted in exactly the same way as the prohibition referendum of last year.

Important Court Decisions

Accompanying the introduction of the bills was a message from Governor Smith in which he declared:

"Since my annual message was transmitted, two decisions of vital importance have been made by the United States Supreme Court, affecting the entire problem of power development and sale. In the so-called Indianapolis Water Co. case, the Supreme Court ruled that not only present replacement value must be considered in fixing rates, but also going value and good will. In this case the good will consisted of a monopoly granted by the people themselves to supply them with water. In another case involving the transmission of power from Massachusetts to Rhode Island, the Supreme Court decided that where power is carried over state lines, the state utility commissions have no right to regulate and to fix prices, and in the absence of any specific authority vested in the Interstate Commerce Commission, there is no regulation at all. Entirely apart from these decisions, the recent history of rate-making in the field of electricity indicates very clearly that very little in the way of safeguards can be expected through regulation, and that the only way of protecting the people of the state is through the power of contract, where the state controls and maintains in its own hands such natural power resources as belong to it.

Legislative Approval First

"I have urged that the Legislature pass a bill setting up a Power Authority, with three commissioners appointed by the Governor with the consent of the Senate; that it vest the state's natural water resources in this Power Authority and repeal the existing laws, but that nothing should be done by the Power Authority toward actual development until a sound and sensible, comprehensive plan of development had been presented to the next Legislature and had been approved by it. The legislative leaders, on the other hand, have contended for a mere investigating commission to decide what the policy of the state ought to be.

To Avoid Political Discussion

"After careful consideration, I have become firmly convinced that an investigating commission would be a sheer waste of time and would simply be a joke at the expense of the people of the state. There is a vital difference in getting prominent and capable men to accept appointment on an investigating commission, compared to getting them to serve on a Power Authority with a definite program to work out. There is also a vital difference between the actions and proceedings of these men after they take office under the one plan, as opposed to the other. We have had investigating commissions and debates on water power since I have been in public life, and most of them have been useless because they usually degenerated into dogmatic statements as to one person's economic views or theories and into generalities and slogans about socialism, predatory interests, etc. I want, if possible, to see this problem solved by lifting it out of political discussion, and I am sure that it cannot be solved by any mere investigating commission."

To Consider Commission Members

The bills were introduced in the Assembly without comment, but in the Senate Majority Leader John Knight bitterly attacked the policy of the Governor. He finally withdrew his objection to the introduction of the bills, but stated that the majority in the Legislature was willing to sit in with the Governor and agree upon the persons who would be named to the temporary commission as proposed in the bill as recently introduced by Senator Hewitt and Assemblyman Sargent.

Unit-Mill Pulverizers, 800 Lb. Boilers for State Line

Six Babcock & Wilcox boiler units built for 800 lb. working pressure, a capacity exceeded by only two other installations, will supply steam to the giant 208,000-kw. turbo-generator ordered by the State Line Generating Co. for the new power station which will be erected on the shore of Lake Michigan, immediately east of the Illinois-Indiana state line. This turbine-generator was dealt with in a recent issue of *Power*.

Of much interest, too, is the fact that the plant is the first large station to adopt throughout unit-mill pulverized-coal equipment. This will be of the Fuller-Lehigh type. These boilers, which will be equipped with Bailey furnaces and burners, are similar in design to, but somewhat larger than, the pulverized coal boiler unit that has been in service since last November in the Calumet station of the Commonwealth Edison Company of Chicago.

Clinch River Projects Mark Time for the Present

With its three members in attendance the Federal Power Commission on March 15 voted "that for the present, no action will be taken on any applications for any project on the Clinch River, on account of the bearing such action might have on the utilization and disposition of Muscle Shoals."

While no mention was made in the resolution of the Commission of the upper Tennessee and its tributaries, other than the Clinch, the action of the Commission is regarded as padlocking the whole Tennessee River to await the disposition of the government's properties at Muscle Shoals.

Argue Relative Merits of Various Shapes for Pressure-Vessel Dished Heads

Comments Made at St. Patrick's Day Hearing of Boiler Code Committee Leave Question of Elliptical vs. Basket H ads Still Open

FURTHER light was thrown on the dished-head discussion at a public hearing of the A.S.M.E. Boiler Code Committee in New York on March 17. The hearing, which was an outgrowth of recently revived interest in the subject of the design of dished heads for pressure vessels and may lead to a revision of the present code, was attended by experts representing manufacturers of boilers and unfired pressure vessels, insurance companies and the "engineering public."

Research Started Discussion

The hearing was an outgrowth of four papers presented on the subject at a combined meeting[1] of the A.S.M.E. and the American Welding Society on Jan. 4, wherein S. W. Miller, H. E. Rockefeller, T. W. Greene and A. B. Kinzell reported and analyzed tests made in the laboratories of the Union Carbide & Carbon Corporation. They contended that the ordinary basket design of head, in which the profile consists of an arc of radius equal to the diameter of the shell connected to the flange by knuckles of relatively short radius, set up severe stresses which could be largely avoided by the use of an elliptical section. A new style of manhole reinforcement was also proposed to avoid undue concentration of stresses at that point.

Preliminary to the discussion C. W. Obert, secretary to the Code Committee, read letters from boiler inspectors and insurance companies saying that they knew of no failures of dished heads constructed under the Code.

Some Heads Have Failed

S. F. Jeter, of the Hartford Steam Boiler Inspection & Insurance Co., called attention to the fact that the A.S.M.E. Code rules had been in operation only since 1914, and that while he knew of no failures of heads constructed under the rules, there had been a number of failures of previously constructed heads which happened to be in line with the Code requirements.

The A. O. Smith Corp. submitted a letter stating that they had definitely adopted the elliptical heads having a depth one-quarter the diameter. This change was due to trouble with the old designs.

Perry R. Cassidy, representing the American Boiler Manufacturers' Association, congratulated the authors on the good job they had done, but feared that they may have unwittingly thrown undue suspicion on the design of riveted drums for power boilers.

In discussing the reports of German and other European investigators, he pointed out the Germans made their boilers of steel, containing eight or nine point carbon, and with phosphorus and sulphur higher than in the United States. Such steel is subject to embrittlement if worked in the blue range of temperature, whereas the higher grades of steels used by American boiler manufacturers are not. Again the Germans use a factor of safety of four, while five is the American standard. These differences, said Mr. Cassidy, account for the greater number of head failures abroad.

He hoped that all the factors would have intelligent attention but that nothing would be said or done to create unwarranted anxiety as to the safety of existing drums.

Careful Study Needed

Among the reasons for not making a change he listed the following: Adoption of new head standards would mean scrapping several hundred thousand dollars worth of dies. In battery settings increased depth of head would waste space. If new formulas required heads thicker than two inches for high pressures, the builders would encounter serious manufacturing difficulties.

In closing, the speaker said that the boiler manufacturers would not oppose any reasonable design and would gladly co-operate in collecting information. They merely wished to keep their feet on the ground and avoid precipitate action.

An expert in dished-head construction said that it would cost less in new dies and fixtures to continue the present basket-shaped head with larger knuckle radii than to adopt the elliptical heads. However, he pointed out that the large knuckle radii increased the difficulty of manufacture.

Conical Heads

A representative of the H. K. Porter Company presented the results of tests made on conical heads. These had proved satisfactory for working pressures up to 1,400 lb.

Mr. Jeter warned against being stampeded into making changes without careful consideration of all the practical factors involved, such as greater space required by deeper heads, cumulative effect of fatigue, effect of corrosion, etc. He felt that the Code rules are fairly safe for solid heads, but that there might be some question in the case of manhole heads. He presented a list of fifteen head failures between 1921 and 1926. All of these cracked at the knuckle.

P. W. Swain, of the *Power* editorial staff, read abstracts of two German papers, one by Dr. W. Otte and the other by E. Siebel and F. Korber. These papers, abstracts of which will appear in an early issue, seemed to show that while elliptical heads are superior to basket heads of ordinary design, basket heads of proper crown and knuckle radii are even better than elliptical heads. Mr. Swain felt that the difference of opinion on this point should be definitely settled before any changes were made that might involve the manufacturers in large expenditures.

Cast Steel Heads

A representative of the Springfield Boiler Company said that experiments were in progress on the use of cast-steel heads for boiler drums to operate at 750 lb. steam pressure. He offered to make all the data public as soon as the tests are completed.

It was suggested by Mr. Jeter that the question of dies would take care of itself if the Code was modified to permit the various types of construction, giving for each a formula that would insure safety. This suggestion seemed to meet with the approval of F. R. Low, who presided as chairman of the Boiler Code Committee.

Mr. Miller discussed the provisions of the Code by which the formula for head thickness includes an additive constant of ⅛ in. or ¼ in. (for solid heads and manhole heads respectively), and he pointed out that while this is satisfactory for thin shells, the percentage increase in thickness grows progressively less for higher pressure and thicker heads.

[1] See *Power* Jan. 11, 1927, for report of this meeting and abstract of papers.

Northwestern Power Engineers Convene at Portland

The fourth annual meeting of the engineering section of the Northwestern Light and Power Association, an organization consisting of the electric power concerns of the Pacific northwest, convened at the Multnomah Hotel in Portland March 10.

Major H. S. Bannion, director of engineering for the National Electric Light Association, delivered an address. W. W. Briggs, vice-president and general manager of the Grays Harbor Railway & Light Company, spoke on the correlation of the operating and commercial departments of producing concerns.

Paper Concern Installs New Central Steam Plant

Crocker-Burbank & Co., paper manufacturers, have decided to build a new central steam plant costing $600,000 for four of their mills, and F. J. Sill, electrical consultant, Westboro, Mass., has been entrusted with the design.

Steam will be generated at about 385 lb., expanding through prime movers and sent on to the mills at 35 lb. The electricity generated will be used partly to drive paper machines, which will be electrified in three of the mills, and the remainder will go into the general power supply of the company. The Crocker-Burbank company will also continue to buy electric power on a large scale.

To Develop Hydro Plant Near Columbia, S. C.

The General Gas & Electric Corp. of New York will spend $20,000,000 in the development of a 200,000-hp. hydro-electric plant on the Saluda River near Columbia, S. C. The dam will be 188 ft. high and will back up a lake 30 miles long.

Diesel Award to Feature Oil Power Week

Meetings in all leading centers throughout the country, on subjects of oil-engine fuels, engine design, operation, economics, trends and research problems, will mark Oil Power Week, April 18 to 25.

To focus general attention on the production of power by the use of oil, which is the purpose of the simultaneous meetings, the national committee announces that it will award a cash prize of $100, accompanied by a suitable certificate to be known as the Rudolph Diesel Award. This award will be made for the best contribution toward the advancement of oil engines, either in the form of a paper presented at one of the meetings throughout the country under the auspices of Oil Power Week, or a written discussion of a paper, by anyone attending any of the meetings.

Manuscripts should be in the hands of the national committee not later than June 1, and the award will be announced by Aug. 1. All communications regarding this competition should be addressed to Edgar J. Kates, Chairman, National Committee, 29 West 39th Street, New York City.

Hoover Proposes Joint Board on St. Lawrence Canal Plan

Speaking before a gathering of New England business men under the auspices of the New Haven Chamber of Commerce March 12, Herbert Hoover, Secretary of Commerce, outlined plans for the St. Lawrence River shipway, and recommended that a joint commission of the United States and Canada be appointed to carry out the undertaking.

In reviewing the need for the canal the Secretary, who was Chairman of the American commission which examined the project in co-operation with the Canadian authorities, said:

"Our American commission has recommended that the construction be undertaken. It would remove a great barrier to world transportation. It is urgent to the prosperity of the vast Midwest. It will contribute a wealth of hydro-electric power. It is a task worthy of the strength and purpose of the two sister nations who have in two centuries already overcome countless obstacles in implanting the most hopeful civilization of history.

Work Simple—Though Stupendous

"Our engineers have determined full plans by which we can ultimately secure a thirty-foot channel admitting to the lakes 88 per cent of all ocean-going vessels which touch North American ports—and thus, great cities like Fort William, Duluth, Chicago, Detroit, Cleveland, Buffalo and Toronto may take their place and part on the seaboard of the world.

"While the works to convert the St. Lawrence to a shipway must be on a stupendous scale they are comparatively simple in character, as are most great things. It is proposed that we shall construct three or four big dams across the St. Lawrence River and thus transform its rapids into great pools, the passing of which by appropriate locks and canals make the shipway.

"During the last fifteen years the perfection of long-distance transmission of electricity to the commercial markets has made possible a large recovery of the cost of these works through the sale of the 5,000,000 of hp. which will fall over these dams.

"It would take some years to absorb this volume of five millions of horsepower. But time moves swiftly in our industrial demands. In so short a time as fourteen years we have increased our use of electrical power on the whole North American continent from less than 17,000,000 hp. until today we are using about 48,000,000.

Power Will Pay Bill

"The development of power," Mr. Hoover continued, "is a fortunate and valuable byproduct. While the total cost of the works on the St. Lawrence will amount to about $600,000,000, our engineers estimate that, after we deduct that portion of the works which will be taken over by the power development, we are left on various estimates with a cost to the Governments of from $100,000,000 to $200,000,000, which itself may some day be recovered from power. This is not a stupendous sum for two nations."

Industrial Show Planned for Cleveland

Indorsed by the Ohio Chamber of Commerce, the Cleveland Industrial Exposition will be held in the Auditorium of that city, Aug. 6 to 28, according to announcement given out by the committee on industrial development of the Cleveland Chamber of Commerce. Exhibition space is available to products manufactured or sold in the northern Ohio district.

The purpose of this exposition is to present a concentrated picture of the industrial activity and human progress achieved by northern Ohio—in other words, to "sell" the Cleveland district, its products and its opportunities, to itself and to the world. It is expected that the exposition will be successful not only in inspiring constructive thought in the community, but in opening to individual exhibitors new market fields, new accounts and increased consumption of the products displayed.

In addition to the exhibits, entertainment will be furnished to visitors in the form of famous bands, orchestras and other open-air features.

Proposed Steam Boiler Rules, As Amended, Get Hearing

Two proposed rules, as amended, relating to the maximum allowable working pressure of power steam boilers will be viewed at a public hearing held by the Industrial Board at the offices of New York Department of Labor, 124 East 28th St., New York City, at 10 a.m., March 23. The proposed changes are in existing installations rules X-1 and X-3, which are parts of general Rule 850.

Indicates Boulder Dam Action —Conference With President

Predictions that legislation for the development of the Boulder Dam project will be enacted at the next session of Congress were made on March 12 by Representative Smith of Twin Falls, Idaho, and Senator Shortridge of California, both Republicans, after they had conferred with President Coolidge at the White House.

Mr. Smith, who is chairman of the House Committee of Irrigation and Reclamation, said orally:

"A recent poll of the House membership on the subject has convinced the friends of the legislation that at least three-fourths of the membership are in favor of the project. I think the Senate also is favorable to the proposal. I do not have any doubt but what the bill will be reported early in the forthcoming session of Congress and passed."

Power Commission Approves Important Project Ruling

No application for a license, under Section 23 of the Water Power Act, for a constructed project will be entertained by the Federal Power Commission unless the applicant holds rights of such character that it may continue its project without securing a federal license.

This ruling of the Commission's chief counsel was approved by the commission itself at a meeting on March 15. Where Section 23 does not apply it is possible for the commission to proceed under Section 4 of the Act, the law officer rules, which means that the fair value of the project as of the date of the license is not applicable as it is in cases under Section 23. Section 4 provides that the net investment must be determined under the provisions of the statute on the basis of actual legitimate, original cost.

Fact-Finding Committee Will Study Colorado River

A fact-finding committee to bring together pertinent and practical information having a bearing on the development of the Colorado River will be appointed May 1 by Secretary Work, on his return to Washington.

The committee, Secretary Work states, is to be "composed of competent, disinterested men able to advise the government and the Department on the merits of the proposition as a whole."

The emphasis which Secretary Work places upon an investigation of the problems of the entire river is regarded as significant.

Minnesota Power Consolidates With Northern States

Formal announcement of plans for merging the properties of the Minnesota Power Co., with the Northern States Power Co., was made March 7 by R. F. Pack, vice-president and general manager of the latter company, on his return from an eastern trip.

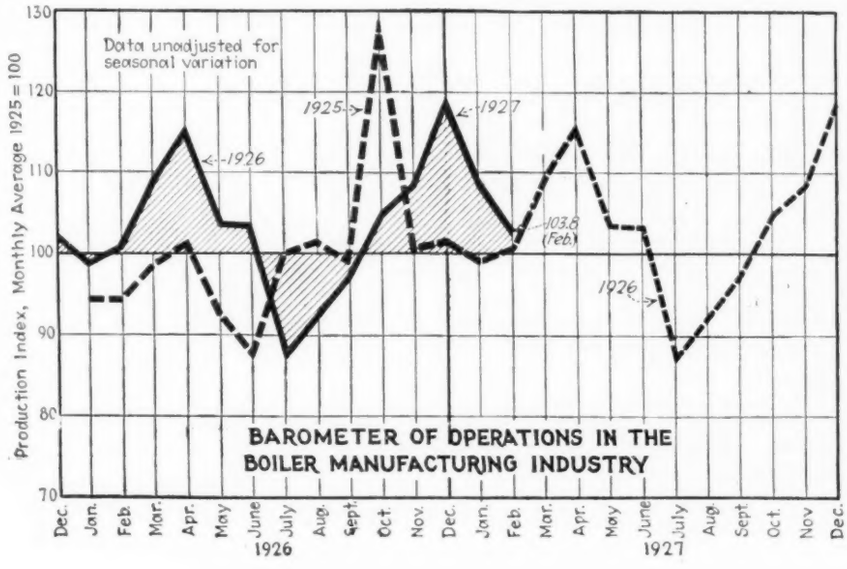
The Minnesota Power Co. serves 10 communities on Lake Minnetonka.

Boiler Output Slightly Over Last Year's Production

As was to be expected, partly by reason of the comparatively small number of working days, the actual production of the boiler-manufacturing plants during February was considerably under that of January. After corrections for number of working days are made, it is found that there was an actual increase of 2 per cent in the productive activities of the boiler-manufacturing plants during February. The actual boiler production was also about 3 per cent over that of February last year. Such is the picture of productive operations in the industry as indicated by the consumption of electrical energy by some fifty of the boiler manufacturing plants of the country.

The first two months of the year found the boiler-manufacturing plants operating slightly above the operations of the same period of 1925 and 1926, but the trend in production this year differs from that reported in former years. Production has been distinctly downward since the unusually high production recorded during December, whereas in former years the December, January and February production has been about on the same level. March witnessed a distinct upward trend in both 1925 and 1926, but whether the present March will witness a similar increased production remains to be seen. There appears to be no basic reason why heavy construction during the first half of 1927 should not be close to that of the same period of 1926, the January and February figures being only slightly below those of the same months of last year. If this trend in heavy construction is maintained during the first half of the present year, the operations of the boiler-manufacturing plants of the country taken as a whole should compare favorably with those of the first half of 1926.

The question has been raised as to whether or not increased electrification within the plants of the companies reporting their energy consumption monthly to *Power* would have some material effect on the apparent production as indicated by the kilowatt-hour consumption. Accordingly, the reporting plants were questioned on this point. In only two cases was increased electrification during the past year reported, and each of these plants was small. It is undoubtedly true, however, that owing to improved operating methods, more efficient machinery and better organization, the boiler-manufacturing plants are gradually increasing their actual production per unit of energy consumed. It is believed, however, that while boiler-production data over long periods of time are probably not possible from energy consumption reports under present operating conditions, yet there is little doubt that comparative yearly production as indicated by energy consumption can be accepted with a large degree of confidence.



Miniature Control Desk Is Developed by Westinghouse

A miniature control desk that consists of essentially standard equipment mounted in a compact form has been developed by the Westinghouse Electric & Manufacturing Co. It greatly facilitates the work of the operator, saving time and energy and assuring efficient and accurate work.

This type of desk is made of ¼-in. stretcher level steel and is shipped in groups of four sections for convenience in handling, but any number of units may be combined to make a complete board. The indicating wattmeters, reactive factor meters and power factor meters are approximately 4 in. in diameter, and have identical movement with the larger and more frequently used switchboard instruments of 5½ in. and 7½ in. diameter.

The ammeters and voltmeters are all high grade instruments although only approximately 2 in. in diameter and the meters are all of the flush type.

Soapless Lubricating Grease Goes To Swan-Finch Oil

The soapless lubricating grease referred to in *Power* several months ago has been acquired by the Swan-Finch Oil Corp., of New York.

Carnegie Tech. Plans Second Coal Conference

A second international conference on bituminous coal will be held at the Carnegie Institute of Technology in November of 1928, according to an announcement by Dr. Thomas S. Baker, president of the institution.

The first conference was called by President Baker for the purpose of finding new uses for bituminous coal and especially to discuss the problem of liquefying coal to supplement the petroleum oil supply of the world. More than 1,700 delegates, including representatives of thirteen different countries, attended. The speakers included Dr. Friedrick Bergius and Professor Franz Fischer, who have successfully liquefied coal; Gen. Georges Patart and Jean Bing, of France; Dr. C. H. Lander, Geoffrey M. Gill, Harold Nielsen, and Dr. R. Lessing, of England; and several other well-known foreign scientists in addition to a long list of prominent American engineers and men of affairs and science.

President Baker stated that the second conference will be planned to uncover whatever new information is made available during the coming two years regarding various problems in the use of soft coal.

Another Power Plant Planned for British Columbia

The British Columbia Electric Railway, which has under construction a plant on the Bride River which will ultimately develop 60,000 hp. at a cost of $30,000,000, is reported to have decided to begin another plant of similar capacity which will cost about $38,000,000.

It is expected that the demand for electric power on the lower mainland of British Columbia will increase to such an extent within the next five years that construction on the new project will be necessary.

Power Plant to Be Installed by Denver Rubber Concern

Work has been begun on designs and specifications for a power plant to supply all power and light required by the group of 20 factory buildings in South Denver operated by the Gates Rubber Co. C. R. Ahlquist, chief engineer of the company, heads a corp of engineers and draftsmen drawing up the layout.

Bleeder turbines operating on 350 lb. steam pressure will be employed.

Obituary

Walter Darling, 28, electrical engineer in charge of construction of a power plant at Dunkirk, north of Kenton, Ohio, was killed March 10 when he came in contact with high tension wires and was thrown thirty-five feet to the ground from the pole on which he was working.

Darling was a graduate of Ohio State University.

Personal Mention

L. J. Hanses has been appointed engineer of miscellaneous construction by the Public Service Company of Northern Illinois.

Harry A. Sweetnam has been appointed superintendent of the electrical engineering department of the Edison Electric Illuminating Co., succeeding Leonard L. Elden.

Leonard L. Elden, formerly head of the electrical engineering department of the Edison Electric Illuminating Co., has been appointed technical advisor to the general superintendent.

Charles S. Hadaway, head of the direct-current electrical division of the generating department of the Edison Electric Illuminating Co., recently completed 40 years of continuous service with that organization.

M. Georges Claude, prominent member of the French Academy of Sciences, before which body he recently outlined a proposition for the production of power from ocean water in the Tropics, sailed for Europe March 10, following a series of lectures at Columbia University.

Maurice L. Sindeband, electrical engineer, has been elected a vice-president of the American Brown Boveri Electric Co. and assumed his duties on March 1, according to announcement. Since 1915 Mr. Sindeband has been in the engineering department of the American Gas & Electric Co., and he was recently elected a vice-president of this company in charge of the electrical engineering department.

Society Affairs

The Florida Section of the American Water Works Association will be held at the Hollywood Hotel, Hollywood, Fla., April 12 and 13. E. L. Filby, State Board of Health, Jacksonville, Florida, is secretary.

The Newcomen Society is planning a gathering of the American members for April 20. The history of technology and engineering will form the basis of papers and topical discussions for this meeting. Suggested subjects should be referred at an early date to C. E. Davies, Corresponding Secretary for America, 33 West 39th St., New York City.

The Institution of Mechanical Engineers will hold its summer meeting in Birmingham, England, beginning June 27 and terminating July 1. The meeting will include visits to Derby, Coventry, Leicester, Rugby and Wolverhampton. The program includes technical papers, inspection of works and entertainment features. The Secretary, The Institution of Mechanical Engineers, Storey's Gate, St. James Park, London, S. W. 1, England.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Oil Burner Association. Annual convention and exposition at Buffalo, N. Y., April 5-7.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa. June 13-16; J. E. Burke, c/o Burke Boiler Repairing Co., 1821 So. Ringgoldl St., Philadelphia.

American Refractories Institute. Spring meeting at Hotel Traymore, Atlantic City, N. J., May 18-19; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman of the Kansas City Section.

American Society of Refrigerating Engineers. Western meeting at White Sulphur Springs, W. Va., May 23-25, in conjunction with the Spring meeting of the A.S.M.E.; W. H. Ross, 35 Warren St., N. Y.

American Society for Testing Materials. Annual convention at French Lick Springs Hotel, French Lick, Ind., June 20-24; J. K. Rittenhouse, secretary, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

American Welding Society. Annual meeting at 29 West 39th St., New York City, April 27-28-29.

Association of Iron and Steel Electrical Engineers. Annual convention in conjunction with Iron and steel exposition at Pittsburgh, Pa., June 13-18, inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention, in conjunction with the Pacific Coast Power Show, will be held at the Ambassador Hotel, Los Angeles, Calif., Aug. 22-27 inclusive, John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18, inclusive, in conjunction with the Northwestern Ohio Power Show; P. H. Grigsby, secretary of convention committee, Lima, Ohio. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention at Anderson, May 27-28.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 8.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Convention at Atlantic City, June 6.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Business Notes

The Blaw-Knox Co. has removed its Philadelphia office from the Colonial Trust Building to 332 Widener Building.

The Wallkill Valley Electric Light & Power Co. of Walden, Orange County, N. Y., has certified its principal office will be located in Ithaca, Tompkins County, N. Y.

The Griscom-Russell Co. has just appointed C. F. Henderson, 542 Call Bldg., San Francisco, as its new agent for the San Francisco territory.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Mar. 14 1927
Pool 1	New York	$2.75@$3.25
Smokeless	Boston	1.83
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.80@ 2.10
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.65@ 1.90
Pittsburgh	Pittsburgh	1.80@ 1.90
Pittsburgh gas slack	Pittsburgh	1.60@ 1.70
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.40@ 2.50
West Ky.	Louisville	1.40@ 1.75
S. E. Ky.	Louisville	1.40@ 1.65
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.75
Birdseye	New York	2.00

FUEL OIL

New York—March 17, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—March 9, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.9c. per gal.; 38@40 deg., 6.7c. per gal.

Pittsburgh—March 7, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6.5c. per gal.

Philadelphia—March 16, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $2@$2.06 per bbl.

Cincinnati—March 14, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—March 7, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.65.

Boston—March 14, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.85c. per gal.; 28@32 deg., 6c. per gal.

Dallas—March 12, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

The Heine Boiler Co. offices at Pittsburgh, Pa., are now in the First National Bank Building.

The Dampney Company of America, Hyde Park, Boston, Mass., announces that the sales of its APEXIOR protective coatings for power plant equipment will be handled in the Chicago district by D. H. Skeen & Co., Monadnock Block.

The D. E. Whiton Machine Co., manufacturer of the Lee steam turbine and governing devices, New London, Conn., has appointed as representatives D. H. Skeen & Co., 1362 Monadnock Block, Chicago, Ill.; Walter S. Bryde Co., 1500 Cadillac Square Bldg., Detroit, Mich.; Riley Engineering & Supply Co., 360 Dufferin St., Toronto, Canada, and I. N. Beeler Co., 504 City Bank Bldg., Syracuse, N. Y.

The Harold E. Trent Co., of Philadelphia, has moved to larger premises at 439-443 N. 12th St., Philadelphia. It is the intention of this company to develop large-sized metal pots and pot furnaces up to 1,700 deg. F., in addition to its standard line of metal melting pots up to 1,500 lb. capacity and 1,000 deg. F. Besides melting pots and pot furnaces, this firm also manufactures soldering irons, solder troughs, calibration tanks, etc.

The Lincoln Electric Co. announces the following changes in its sales personnel. G. N. Bull, formerly with the Worthington Pump & Machinery Co. in the Washington, D. C., office, has been made district manager of the New York office; C. S. Freeman, formerly in charge of the Lancaster office, has been transferred to the Buffalo office and made district manager; S. W. Schultz recently of the Philadelphia office, has been put in charge of the Lancaster office, and Ed. J. Pfister, of the Buffalo office, has been transferred to the Philadelphia office.

Trade Catalogs

Automatic Temperature Control.—The Sarco Co., Inc., 183 Madison Ave., New York City, has issued a pamphlet entitled "The Widening Field of Temperature Control," by Joseph A. Maguire, consulting engineer to the company. In the mentioning of this pamphlet in the March 8 issue of *Power*, the name of company appeared as The Sargo Co., through a typographical error.

Electrical Instruments for Signal System Testing.—The Roller-Smith Co. Supplement No. 1 to Bulletin No. 100. This covers several types of instruments which are used principally in signal system and automatic train-control work. The instruments themselves are not new ones, but are standard devices modified to meet the requirements met with in testing of these classes.

Lee Steam Turbines.—The D. E. Whiton Machine Co., New London, Conn., has issued Bulletin 401 on its Lee steam turbines for driving boiler feed and circulating pumps, pulverizers and stokers, generators, blowers, exhausters and other equipment requiring a prime mover.

Supplies, Equipment and Service.—The Fitchburg Steam Engine Co., builders of four valve and single valve horizontal and vertical engines and high speed, uniflow and Prosser engines, Fitchburg, Mass. Special bulletin No. 21 describes a number of power plant supplies of especial interest.

Type FR Relays for Alternating Current and Direct Current.—The Roller-Smith Co., 233 Broadway, New York City, has issued Supplement No. 1 to Bulletin No. 550. This covers the new type FR line of relays. These relays are used for many purposes, but one of the principal applications is in connection with contact-making instruments, meters and similar devices, wherein it is desired to have a small current operate devices requiring a relatively large current. The type FR relay is a new device not previously described in any trade paper.

New Plant Construction

Calif., Los Angeles—English Realty Corp., awarded contract for the construction of an 8 story apartment building at Fourth St. and Normandie Ave. to E. C. English, 401 South Normandie Ave. Estimated cost $900,000. Steam heating system, elevators, etc. will be installed.

Calif., Los Angeles—J. Oviatt, c/o Walker & Eisen, Western Pacific Bldg., Archts., awarded contract for the construction of a 12 story office and stores building at 615 South Olive St. to P. J. Walker Co., W. M. Garland Bldg. Estimated cost $600,000. Steam heating system will be installed.

Calif., Los Angeles—H. Ruff, Franklin Ave., awarded contract for the construction of a 12 story hotel at Fifth and Figueroa Sts. to John M. Cooper, 301 Rives-Strong Bldg. Estimated cost $500,000. Steam heating system, electric elevators, etc. will be installed.

Calif., Los Angeles—United Artists' Theatre Corp., 922 South Olive St., awarded contract for the construction of a 13 story theatre and office building at Broadway between 9th and 10th Sts., to Scofield Engineering Construction Co., 621 South Hope St. Estimated cost $1,050,000. Steam heating and ventilation systems, elevators, etc., will be installed.

Calif., Santa Cruz—Union Ice Co., 354 Pine St., San Francisco, is having plans prepared for the construction of a 30 ton ice plant on Laurel St., here. Estimated cost $60,000. Private plans.

Colo., Denver—Mountain State Telephone & Telegraph Co., Telephone Bldg., awarded contract for the construction of a 15 story office building at 14th and Curtis Sts., to C. E. Walker Construction Co., Central Savings Bank Bldg. Estimated cost $2,500,000. Bids will soon be taken for steam heating system, etc.

Conn., Fairfield—McKesson-Robbins, Inc., c/o Fletcher-Thompson, Inc., 542 Fairfield Ave., Bridgeport, Archts., is receiving bids for the construction of a factory and boiler house on Grasmere Ave., here.

Conn., New Britain—New Britain Gas Light Co., 23 West Main St., awarded contract for the construction of a gas generator station and blower building to Record & Johnson, 122 Main St. Estimated cost $40,000.

Ill., Chicago—Chicago Eye, Ear, Nose & Throat Hospital, 235 West Washington St., will soon award contract for the construction of a 10 story hospital including steam heating system at Franklin and Washington Sts. Estimated cost $700,000. A. S. Alschuler, 28 East Jackson Blvd., Archt.

Ill., Chicago—Plotke & Grosby, 111 West Washington St., awarded contract for the construction of a 16 story hotel at 210 East Pearson St. to Trimmer-Nydle, 111 West Washington St. Estimated cost $2,000,000.

Ill., Chicago—Ridgewood Court Building Corp., c/o Leichenko & Esser, 38 South Dearborn St., Archts., is receiving bids for the construction of a 4 story apartment, including steam heating and refrigeration systems, 2 elevators, etc., at Ridgewood Court and Kenwood Ave. Estimated cost $650,000.

Ill., Chicago—Quinn & Christensen, 360 North Michigan Ave., Archts., are receiving bids for the construction of a 9 story hotel including central refrigeration plant, elevator, etc., at Everett Ave. and 56th St., for Saranac Building Corp. Estimated cost $750,000.

Ill., Rockford—George D. Roper Corp., South Main St., will soon receive bids for the construction of a factory and power plant. Estimated cost $200,000. Private plans.

Ia., Decorah—Interstate Power Co., Dubuque, does not plan the construction of a power house and dam near Decorah. This corrects report of Mar. 15 issue.

Ia., Eagle Grove—City defeated $65,000 bonds for the construction of a power plant. H. L. Cory & Co., 307 Dakota Bldg., Aberdeen, S. D., are engineers.

Ia., Sheldon—City plans an election soon to vote $90,000 bonds for the construction of an electric light plant.

Kan., Atchinson—Pillsbury Flour Mills Co., 302 Metropolitan Life Bldg., Minneapolis, Minn., awarded contract for the construction of mill, storage tanks etc., including motor driven conveying and elevating equipment, etc., to Folwell-Alskog, 323 North Main St., Chicago, Ill. Estimated cost $200,000.

Mass., Boston—Edison Electric Illuminating Co., 70 State St., awarded contract for the construction of a 2 story power plant at Arch and Hawley Sts., to F. T. Ley, 230 Boylston St.

Miss., Gulfport—L. E. Deutsch & E. Milgrim, will receive bids about Apr. 1 for the construction of a 6 story hotel including steam heating system, two elevators, etc., at 14th St. and 26th Ave. Estimated cost $500,000. N. W. Overstreet, Mississippi Fire Bldg., is architect.

Mo., Columbia—Bd. of Education will receive bids until Apr. 12 for the construction of a heating plant. Estimated cost $65,000. W. B. Ittner, 408 Bd. of Education Bldg., St. Louis, is architect.

Mo., St. Louis—Bd. of Public Service, is having preliminary plans prepared for the construction of a 4 story auditorium on Plaza St. Estimated cost $5,000,000. Memorial Plaza Comn., c/o Bd. of Public Service, is architect and engineer.

Mo., Stanberry—City, J. A. Moore, Clk., plans an election Apr. 5 to vote $30,000 bonds for the construction of an electric light plant and distribution system.

N. H., Concord—J. D. Leland & Co., Statler Bldg., Boston, Mass., Archts., will receive bids until Mar. 29 (extended date) for the construction of addition to hospital, nurses home, power house, etc., for Margaret Pillsbury General Hospital, Concord, N. H. Estimated cost $150,000.

N. Y., Brooklyn—Brooklyn Union Gas Co., 126 Remsen St., awarded contract for the design and construction of a by-product coke and gas plant to The Koppers Construction Co., Union Trust Bldg., Pittsburgh, Pa. Plant will consist of nine Koppers gas producers, with a complete coal and coke handling system and equipment for recovery of by-products, etc.

N. Y., New York—Clent Construction Co., G. F. Pelham, 570 7th Ave., Archt., is having plans prepared for the construction of a 30 story apartment including steam heating system, elevators, etc., at Madison Ave. and 89th St. Estimated cost $2,500,000.

N. Y., New York—Klein & Jackson, 501 5th Ave., are having plans prepared for the construction of a 22 story bank and office building including steam heating system, elevators, etc., at Madison Ave. and 60th St. Estimated cost $4,000,000. W. L. Rouse, 512 5th Ave., is architect.

N. Y., New York—One Hundred Eighty Four Fifth Ave. Corp., c/o Warren & Wetmore, 16 East 47th St., Archts., is having plans prepared for the construction of a 31 story office building including steam heating system, 8 elevators, etc., at 5th Ave. and 47th St. Estimated cost $2,000,000.

N. Y., New York—Rhoades-Lennedy Security Co., 342 Madison Ave., awarded contract for the construction of a 15 story apartment at 459 East 57th St., to T. E. Rhoades & Co., Inc., 342 Madison Ave. Estimated cost $2,000,000. Steam heating system, elevators, etc., will be installed.

N. Y., Potsdam—Lawrence Valley Power Corp., subsidiary of the Aluminum Co. of America, Oliver Bldg., Pittsburgh, Pa., awarded contract for the design and construction of a hydro-electric plant including power house and dam, 50 ft. high and 900 ft. long on the St. Regis River near here, to Ambursen Construction Co., Inc., Grand Central Terminal, New York, N. Y.

Okla., Ponca City—City will receive bids until Mar. 31 for the construction of a power plant. Estimated cost $75,000. Burns & McDonnell Engineering Co., 401 Interstate Bldg., Kansas City, Mo., are engineers.

Pa., Bloomburg — Magee Carpet Co. awarded contract for the construction of a boiler house to The Dresser Co., The Arcade, Cleveland, O. Estimated cost $75,000.

Pa., Philadelphia—Philadelphia College of Pharmacy & Science, W. C. Braisted, 145 North 10th St., awarded contract for the construction of a college building and boiler house at 43rd and Kingsessing Sts., to Wark Co., 1600 Walnut St.

Pa., Pittsburgh — Duquesne Light Co., 435 6th Ave., is having plans prepared for the construction of a switch house. Estimated cost $900,000. Private plans.

Pa., Pittsburgh—William Penn Hotel, had plans prepared for the construction of a 25 story addition to hotel. Estimated cost $5,000,000. J. Breslove, Oliver Bldg., is consulting engineer.

Tex., Crowell—H. E. Ferguson is having plans prepared for the construction of a hydro-electric plant near here. Estimated cost $100,000. Private plans.

Tex., Eagle Lake—Riverside Irrigation Co. plans complete electrification of their irrigation plant and system to increase the capacity to 1,500 hp. Estimated cost $50,000. Private plans.

Tex., El Paso—El Paso Electric Co., T. P. Walker, Mgr., is having plans prepared for extensions and improvements to power plant, also the installation of two high pressure boilers, coal handling equipment, etc., to increase the capacity. Estimated cost $1,000,000. Private plans.

Tex., Harlingen—F. M. Discus, c/o Vanetain Estates, is having plans prepared for the construction of a 6 story hotel including steam heating and refrigeration systems, boilers, elevators, etc. Estimated cost $500,000. B. A. Elwing is architect.

Tex., Levelland—City will receive bids after May 1 for improvements to waterworks and sewage systems including sewage disposal plant, well, pumping equipment, tank on tower, etc. Estimated cost $75,000. Hawley & Roberts, Lubbock, are engineers.

Tex., Lometa—Lampasas Ice & Refrigerating Co., Lampasas, plans the construction of a cold storage plant here. Estimated cost $30,000. Private plans. Complete machinery and equipment will be required.

Tex., Midland — Morgan Utilities Co., Inc., L. F. Troxel, Little Rock, Ark., will not construct an electric light and ice plant here. Estimated cost $200,000. Project definitely abandoned.

Tex., Putnam—Humble Pipe Line Co., Houston, will build an oil pumping station, 20,000 bbls. daily capacity near here. Estimated cost $500,000. Private plans. Machinery will be required. Work will be done by company forces.

Tex., San Antonio—Merchants Transfer Co., F. Cannady, Main Ave., plans the construction of a dry and cold storage warehouse on Dorlorosa Ave. Estimated cost $2,000,000.

Tex., San Benito—Holly Beach Inc. and Bayside Development Co., have been granted water permit for irrigation improvements at Laguna Madre near San Benito. Plans include two large pumping plants, probably electrically driven machinery, etc. Estimated cost $300,000. Private plans.

Va., Fort Mnoroe — Constructing Quartermaster will build three boiler houses with mechanical installation, etc.

Wash., Seattle — Sovereign Investment Co., plans the construction of a 12 story apartment including two electric elevators at Boren Ave. and University St. Estimated cost $800,000. E. W. Morrison, Lloyd Bldg., is architect.

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Equipment Wanted

Air Compressor—Church-Tyler Co., 200 Congress St., Boston, Mass., is in the market for a 600 cu.ft. air compressor, 100 lb. pressure.

Air Compressors—Dept. of Public Welfare, J. E. Harper, Ninth and Oak Sts., Columbus, O., is in the market for two steam driven air compressors, large capacity for Institution for Feeble Minded.

Boiler — T. L. Todd, Comn. of Public Property, Henderson, Ky., will soon receive bids for a steam boiler for electric light plant.

Boilers, Stokers, Etc.—T. S. Shlemenson, str. Lekert, 5/3 Odessa, United States, Soviet Russia, prices and catalogs on boilers, stokers, conveyors, pulverized fuel systems, turbines, oil engines and meters.

Carbon Dioxide Recorder—B. Wells, 141 Garrett St., Schenectady, N. Y., is in the market for a portable carbon dioxide recorder or indicator to use in boiler heat balance work.

Coal Handling Towers and Plant—Ring Construction Co., H. E. Ring, 42 Maple St., Bangor, Me., is in the market for coal handling towers and plant.

Compression Testing Machine — W. K. Hoare, Purch. Agt., Cleveland, O., will receive bids until Mar. 25 for a 200,000 lb. compression testing machine.

Engine and Generator—City of Purcell, Okla., is in the market for a 500 hp. Diesel engine and generator for proposed electric light plant. Estimated cost $60,000.

Engine and Generator—J. E. Hale, Supt., Water Valley, Miss., is in the market for a 500 hp. Diesel engine, electric generator and exciter for electric light plant.

Engines, Etc.—City of Ponca City, Okla., will receive bids until Mar. 31 for two 1,250 hp. Diesel oil engines.

Ice Plant—H. A. Braun, Guthrie, Okla., is in the market for a 10 ton ice plant equipment to be installed in a new plant at Coyle.

Light and Power Unit — City Supply Dept., H. S. Frost, Supt., Boston, Mass., will receive bids until Mar. 28 for furnishing and installing a light and power unit including dynamo and engine complete in Institution Dept., Long Island.

Meter—W. J. Lloyd, Union Oil Co. of Canada, 402 Pender St. W., Vancouver, B. C., is in the market for a portable steam flow meter.

Motors, Etc.—Ontario Boat & Engine Co., J. Beebe, Mgr., Wallaceburg, Ont., is in the market for motors, parts, and general equipment for manufacture of high speed motor boats. Estimated cost $40,000.

Pump—City of Gustine, Calif., plans to purchase a deep well turbine pump with equipment.

Pump, Motor, Etc.—Paradise Irrigation Dist., J. E. Alley, Secy., Paradise, Calif., will receive bids until Apr. 5 for one 1,350 g.p.m. Byron Jackson No. 5 deep well pump, 16 in. 4 stage, against 130 ft. head, one 60 hp. G.E. electric motor, 440 v. 1,200 r.p.m. and one G.E. electric auto starter. C. R. 7051.

Pumps—Bd. of School Comrs., U. M. Frazer, Bus. Dir., 150 Meridian St., Indianapolis, Ind., will receive bids until Mar. 29 for condensation pumps for schools 41 and 39, also vacuum pumps in schools 11 and 12.

Pumps, Etc.—New Zealand Government Rys., Auckland, N. Z., will receive bids until June 13 for fuel oil pumps, hydraulic pumps and accumulators, etc.

Pumps, Motors, Etc.—H. G. Denton, Clk., Sacramento, Calif., will receive bids until Apr. 14 for three pumps, three motors and auxiliary equipment for sewage pumping station 2. Estimated cost $35,000.

Pumping Equipment—I. J. Hensel, Clk., North Mankato, Minn., will receive bids until Mar. 28 for pumping equipment, etc., for proposed waterworks system. Estimated cost $20,000.

Refrigeration Equipment — Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until Apr. 13 for refrigeration equipment for Veterans Memorial Hospital at Kings Park, N. Y.

Refrigeration Equipment—U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until Apr. 12 for furnishing and installing automatic refrigeration equipment in U. S. Veterans Hospital at Oteen, N. C., also at Maywood, Ill.

Transformers, etc. — Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, Ont., will be in the market for transformers, cables, switchboards and electrical equipment for proposed transformer stations at Queenston, Ont. Estimated cost $100,000.